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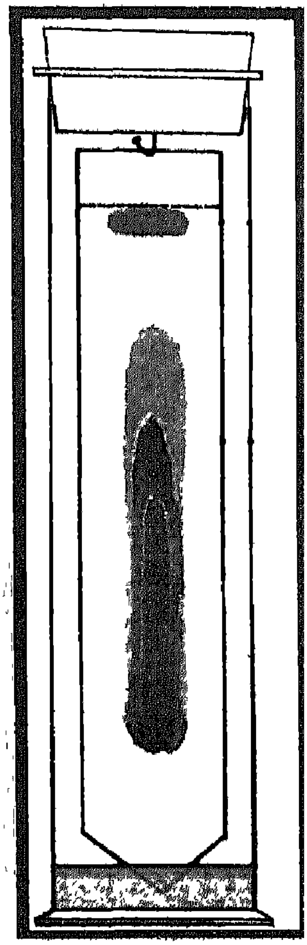

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An Urgent Need for Inclusion of GIS in the Curriculum of Geography and Computer Science

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In our country some of the latest developments in technologies in many of the educational fields are not incorporated at the right time. Sometimes they are not recognised as simple initial stages. But, if seen deeply, it will be revealed that they are very fundamental in the context of growing computer education and their applications. In the present day situation, many subject areas at the stages of elementary education lack proper emphasis on important applications desired. These applications will not only make that subject more interesting to the students but also attract many talents in that area. We would see that same contents are actually being taught in different stages at the school level in the present curriculum. Perhaps the one being suggested here exists but not in a form desired in the present day situation.

The application of GIS — Geographical Information System technologies in the curriculum of Geography at the school level. Though it may initially sound to be something from a higher platform, but with the changing character of education this would emerge as an indispensable area for the subject. Its inclusion would not only change the character of the entire subject of Geography as a science of the Earth, but also help the country to collect the maximum data needed for the micro level planning for the country planners. It is still seemingly obscure but through this dissertation we would like to emphasise that it is inevitable in the present day situation. Inclusion of GIS in the curriculum will make the study of Geography very exciting and useful. More importantly the data acquisition will become very easy. There will be mass involvement of the education system in data collection process. Enormous quantities of accurate data will flow from various institutions with the latest updations. Both the objectives of data collection and organisation will be met without extra effort in collecting data.

What is GIS after all? Nowadays all students are taught what are maps and to what extent they are informative, etc. Think of a map which will give everything and anything whenever you want! Is it not something interesting? Think of geography with all the information you need! The information of a particular man of a country, his state, district, town, his locality then his own house and himself. Is it not exciting! We will be just crazy to have such an exhaustive coverage of the subject. This will give everything that will be geographical information about the near-surface, above and below the Earth, such as elevation, temperature, population density, literacy, occupation and resources of different types. It will be more so when we know that such things would be possible by application of computer software usage that is specially prepared for this purpose. This software is readily available for their useful application. It is not a dream now. Besides all these, we can be a part in creating this information base and facilitate in further development.

Let us know what **GIS** is. **G**—Geography (The Globe, near-earth, above and below, Map, Layers), **I** — Information (Physiography, Hydrogeology, Soil, Land Use, Resources, Socio-economic parameters), **S**—system (Computer Hardware, Software, Database Libraries). It is presently seen as the most versatile technology option for the policy makers. Spatial Decision Support System (SDSS) is entirely dependent on the relational databases When the relational databases are easily available for the entire country at the micro-level it would not be difficult for the economists and managers to arrive at the optimum solution for any kind of problem

If the present stock of situation is taken, we will see that the education system has introduced quite a bit of computer learning in the curriculum. The exposure and the use of computer begins quite early In many parts of the country the tie-ups of the schools with the computer training institutes has improved the learning process, too. Now what remains is utilisation of the knowledge and application in proper area that would change to a large extent. Presently, the course of geography invariably contains preparation of maps as a core element, with all the elementary methods dealing with scales, etc. Actually these are also the basics of the preparation of the software with slight application of mathematical principles in various type of maps with layers, supplemented with exact latitude (Lat) and longitude (Long) data that could be collected by using a Global Positioning System (GPS). Maps and map layers are easily dealt where each layer of a map means information on any of the criteria or parameter like roads, watersheds and run-offs, power plants and soil type. If dealt properly, perhaps it would not be difficult to understand that more useful application software also could be developed once the GIS is introduced in its real essence in the course content of geography.

What is the current status of GIS applications? It is quite well developed and prepared for make its appearance as a key element of the course content of Geography, Geology and Geophysics. Many commercial conversions are available at present of use. Some these are ArcInfo, Arc View, Map Info, ArcGIS and GRAM++. The first four of the software/applications have been in use for quite some time while the package of GRAM++ has been developed indigenously by Scientists of our country. This can be very judiciously used for education and training at different levels and would not be a very expensive affair in any case.

As expected the GRAM++ an acronym for Geo Referenced Area Mangement also have incorporated many features that would attract any of the students of Geography, Geophyscis, Geology, Civil Engineering and Geo-Science This is a PC-based package that runs on Windows 9x/NT environment unique for its userfriendliness. The key features among these are — drawing of maps on different scales representing them in either Raster form and Vector form depending on the requirement. The Raster form is the usage of scaled pixels for maps. Whereas the Vector form gives the position with respect to a reference point in a frame. The maps thus can have points, lines and polygons. Using raster and vector data it is possible to prepare layouts for visualization. The cartographic outputs can be obtained by using lebels, legends, symbols, etc., with desirable scales and projections. GRAM was initially developed after study and usage of the existing packages have been developed in the Indian context suitable to the existing conditions and the kind of requirement that are often to be taken into account. It has also been revised according to the requirement while using it for various purposes resulting to GRAM++. Since the package involves so many other tools than the ordinary map editing or importing and exporting of data. The positional and non-positional data are very nicely manipulated for the graphical representations and outputs desired. Many features exists beyond the map digitisation and its relational databases Its use as a decision support system in management is usage of mathematical and statistical applications. Essentially this software is coding in Visual Basic with algorithms in Visual C++ and using MS-Access data. Libraries have been created as ActiveX controls. Image handling tool has been one of the main features in order to handle remote sensing data. Tools exist for transformation, enhancement and classification.

Nowadays the computer learning in school has begun from the primary classes and the teaching of programming with compilers such as Visual C++ and Visual Basic exist as a part of the syllabi of Computer Science in many good schools. So the inclusion of GIS Would be of worth right from the school level. It has been pointed out by some of the top administrative authorities that the planners do not tend to use the modern tools and techniques in planning. How will it be possible unless it finds a place at the grass root level? Perhaps some combinations like Geography, Economics and Mathematics/Statistics would be ideal for good management base. Even otherwise, the inclusion of GIS in the course of Geography and Computer Science will change the present status of these subjects sufficiently. Needless to add that the scope will be broadened with all these essential elements. Relevance, importance and urgency of GIS felt by all the academicians at present is a must for prospective courses of both subjects of Geopraphy and Computer Science.

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Computer Assisted Instruction on Achievement in Science in Schools

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The present-day society characterised by the presence of ever-growing technology and information explosion. An important feature of education has been its use as physical and intellectual tool. Computer is gradually becoming a familiar and potent tool in teaching/learning in Indian schools. Education must reflect the influence of technology. Appropriate computer technology places users in control of their own learning. It encourages both independent and collaborative learning, while extending and supporting the learning process. Teaching through Multimedia offers an interactive environment for all subjects and skills. Young children respond quickly and naturally to appropriate technologies, which frequently offer a high level of physical control and quick feedback in a variety of forms. Use of technology enhances effectiveness of a learning experience.

Need for the Study

Education for the 21st Century definitely needs a lot of re-thinking on modernisation in the wake of increasing globalisation and setting up of e-communities and readiness for e-commerce. The content and methodology of the present system of education must undergo a metamorphosis. Considerable efforts have been made on revising and updating the syllabus by the agencies of State Board of Secondary Education and the NCERT in the school curriculum. It is a challenging task to change the content and methodology of teaching particularly because of the ever increasing number of students in our classrooms and lack of hardware and software. Nowadays, more and more schools are having computers at the higher secondary schools. Though most of schools use computers to develop awareness and basic skills to work with the systems through hands-on-experiences. The ready-made software for different subjects from Classes I to XII are also available now commercially. A few schools are purchasing and using them to supplement teaching and for the enrichment of the students. The use of Computer Assisted Learning (CAL) in schools is gaining momentum. The investigators of the present study are science teachers, they were interested to conduct a study on the effect of CAL on achievement in Bio-zoology among higher secondary students.

Objectives of the Study

The objectives of the study are

(i) to find out the effect of Computer Assisted Instructions (CAI) on achievement in four units in Bio-zoology* among higher secondary students.

(ii) to find out the effect of Computer Assisted Instructions on achievement in the learning objectives as such on Knowledge, Comprehension, Application and Skills.

(iii) to find out the effect of Computer Assisted Instruction on Achievement in Bio-zoology over lecture method.

Design of the Study

The study was an experimental research. The design of the study was the Pre-Post Equivalent group one. The dependent valuable in the study was the achievement in Bio-zoology and independent variable was the CAI software in Bio-zoology of Students of Class XI

Sample Selection

The procedure followed for the selection of the sample selected for this experiment was purposive random sampling. There are two Govt. Higher Secondary Schools at Krishnagiri. One was selected as control and another the experimental school. The strength of control group and experimenting group was 34 and 31 students respectively. All the students studying in Bio-zoology at Class XI level were selected as the sample for the study.

Development of Achievement Test

As the ready-made Achievement Test in Bio-zoology (ATB) was not available, the investigator prepared it. It was decided to use only multiple-choice items for the ATB. A deliberate attempt was made to provide adequate weightage to different units while selecting items to prepare ATB. Total items selected from the units were 105. The prepared items were given to the two subject experts who were teaching Bio-zoology in schools, for content validity. Based on their comments the ATB was modified. Then it was administered to 20 students of Class XI for assessing its reliability. The split-half method was followed in the study The found reliability co-efficient was 85. The result showed that the tool was reliable

Development of CAI Software

The Computer Assisted Instruction Software on Bio-zoology was developed by the investigator for using it as treatment in the experiment The preparation of software was in 'Visual Basic'. CAI is a self-instructional process. The development of CAI consisted of two stages. First stage dealt with the preparation of skinners Programmed Learning (PL) for the selected units in Bio-zoology. The second stage refers the conversion of PL material into computer software. Hence the software would have the features of meaningful increment of information, active participation of the learner, immediate feedback and learning at his own speed etc. The CAI software was administered to 10 students in pilot study. Seven out of 10 have scored around 90 per cent marks. The remaining three scored around 80 per cent From this it was assumed that the developed CAI Software was valid for external uses.

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* At the senior secondary stage Zoology is taught as a part of Biology Bio-zoology here refers to zoology related content in prescribed course of Biology.

Data Analysis

Different statistical techniques were used with study for developing and validating the programmed learning material, CAI software and analysing the data. Gain score from pre-and post-test was taken for analysis of data. Percentage Correlation and 't' test were calculated to analyse the data. The results are presented in the following table.

It is understood from Table-1 that the calculated 't' values 6.7863, 2.4033 and 2.2034 for the learning objectives of knowledge, Application and Skills among control and experimental group are found to be significant at 0.05 level. The higher mean values of the experimental group may be due to the effect of CAI At the same time there exists no significant difference on 'Understanding' among control and experimental group. This may be understood that both control and experimental group are having similar effect in this aspect.

From the Table 2 the calculated 't' values of 3.2182, 2.9118, 3 3548 and 3.6765 are found to be significant difference at 0.05 per cent level. The higher mean values of experimental group in all units may be due to the effect of CAI:

Table-3 reveals that the observed 't' value of 3.9199 in Less than the table value 2.000 which shows that there was significant difference on the achievement among control and experimental group.

TABLE 1

'T' Test for the Gain Score of Control and Experimental Groups on Achievement in the Learning Objectives

Sl No	*Learning Objectives*	*Group*	*No*	*Mean*	*S D*	*Calculated 't' values*	*Remarks*
1.	Knowledge	Control	34	14 8824	2 1525	6.7863	Significant
		Experimental	31	18.3871	2 0109		
2	Understanding	Control	34	14.9412	1.9242	1.5160	Not Significant
		Experimental	31	15 8387	2.7368		
3	Application	Control	34	14.8824	2 5060	2.4033	Significant
		Experimental	31	16 4194	2.6369		
4	Skill	Control	34	11.2353	2.5637	2 2034	Significant
		Experimental	31	12.4839	2 5637		

TABLE 2

'T' Test for the Gain Scores on Different Units of Control and Experimental Group

Unit	Groups	No.	Mean	S.D.	Calculated 't' values	Remarks
I	Control	34	16 4412	2.6143	3 2182	Significant
	Experimental	31	18 8387	3 3127		
II	Control	34	12 5588	1 7353	2 9118	Significant
	Experimental	31	14 0323	2 2787		
III	Control	34	15 7059	1.8235	3 3548	Significant
	Experimental	31	15 3871	2 1802		
IV	Control	34	13.2353	1 9563	3 0765	Significant
	Experimental	31	14 8710	2.2964		

TABLE 3

'T' Test for the Gain scores of Control and Experimental Group of students in different Units

Groups	No	Mean	S D.	Calculated 't' values	Remarks
Control	34	55.9412	6.0242	3.9199	Significant
Experimental	31	63 1290	8 4347		

The higher mean values of experimental group in all units may be due to the effect of CAI

Findings

Findings of the study are

(i) Students taught through CAI achieved significant different in the attainment of the learning objectives pertaining to the realm of knowledge, application and skill whereas there was similar effect on 'understanding' among control and experimental groups.

(ii) Significant effect was observed on the achievement in favour of CAI in all aspects of learning

(iii) CAI students scored significantly higher marks over the control group students.

Conclusion

Computer Assisted Instruction has made favourable impact on the achievement all the units. When the achievement was analysed as the learning objectives, CAI has produced significantly higher achievement over the control group students on the learning objectives of 'Knowledge' 'Application' and 'Skill' where as similar effect was observed on 'understanding'.

From the study it could be inferred that CAI could be an effective tool to a teacher in the class-room instruction It may be noted that the government and private institutions are taking steps to equip the schools with hardware and software, mainly to provide an opportunity to develop awareness as well as hands-on experience with computers However, it is strongly felt that there must be a change in attitude to promote the use of computers in teaching/learning of different disciplines at all stages of school education.

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Green House Gases (GHGs) and the Perils of Global Warming

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Environment is the most talked about subject today, but at the same time the most ill-understood. Etymologically, the word environment means surroundings. The environment, therefore, refers to the surroundings that is responsible for the survival and development of all living beings and organisms including microorganisms.

The word environment has been perceived differently by different environmentalists and environmental scientists who have come out with different definitions about environment. However, it is worthwhile quoting the following definition given by the environmentalist C C. Park as far back in time as 1980: 'The environment refers to the sum total of conditions that surround man at a given point in space and time'

From a scientist's point of view the environment basically consists of a biotic (living) component, a non-biotic (non-living) component and an energy component. However, when viewed holistically, man and his society cannot be excluded from the ambit of environment as is also reflected in the above-quoted definition of environment.

There is now a growing concern about environmental degradation. Certain gases released into the atmosphere may not only act like pollutants but may also cause hole in the ozone layer or may even lead to global warming In fact, there are some gases, called green house gases (GHGs), which trap the Earth's heat and do not allow it to go out of its atmosphere. This leads to the warming of the Earth known as global warming So, the atmosphere acts like a green house The phenomenon of trapping of heat by the atmosphere is referred to as green house effect. It is interesting to note that the term 'green house effect' was first coined by J Fourier in 1827. Actually, a green house refers to a house or chamber that houses plants or vegetation in cold countries. A green house is usually made of glass although these days plastic green houses are also in abundant use. Basically, a green house provides a warm environment to the plants which cannot withstand the external harsh conditions of the cold climate.

When solar radiation falls on the green house, the glass walls, which have the property of selective absorption, become transparent to the short-wavelength radiation and therefore allow it to pass through. As a result, the interior of the green house warms up. The plants and the flooring of the green house chamber emit the long-wavelength heat (or infrared) radiation. The glass walls are, however, less transparent to this kind of heat radiation. The heat from the interior of the green house is, therefore, not allowed to pass through the walls. This process helps to keep the interior of the green house warm, thereby enabling the plants to survive and thrive in the cold, hostile climate.

One actually comes across several practical instances of green house effect in day-to-day mundane life without even realising it. For instance, a car owner leaving his car in the open sun finds the interior of the car badly heaten up when he returns to it after some length of time. This is attributed to the green house effect An identical process occurs in a box-type solar cooker which some families use for the cooking of their food.

Certain gases present in the Earth's atmosphere can too act like the glass walls of the green house producing the green house effect. These gases, which are principally polyatomic in nature, act like green house gases (GHGs). These gases absorb the long-wavelength infrared (IR) radiation emitted by the Earth's surface and reduce its escape by 40 per cent relative to an atmosphere-free Earth.

To understand the mechanism of absorption it will be instructive to note that in addition to the translational and rotational motion, the polyatomic molecules can exhibit vibrational motion too. (On the other hand, the monoatomic molecules have only translational motion while diatomic mole-cules exhibit translational as well as rotational motion) Due to the vibratory motion, the polyatomic molecules possess vibrational energy. In natural operation of the scheme of things, the average energy of the IR radiation matches the vibrational energy of the polyatomic molecules present in the atmosphere. As a result, the IR radiation is absorbed by these molecules which get changed into vibrationally excited molecules. The excited polyatomic molecules by colliding with other molecules convert the excess vibrational energy into heat. This is radiated back to the Earth resulting in a 'heat trap' causing rise in the atmospheric temperature.

The polyatomic gases responsible for green house effect are mainly carbon di oxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), halons (organic compounds containing bromine and fluorine, such as, dibromo tetrafluoro ethane or $C_2Br_2F_4$), water vapour etc. Sulphur di oxide (SO_2) and ozone (O_3), otherwise regarded as pollutants, may also have the potential of acting like green house gases. It is also suspected that carbon monoxide (CO), the noxious gas that reduces the oxygen-carrying capacity of the haemoglobin, can too act like a green house gas. But, so far the scientists have not been able to come out with a plausible explanation as to how a diatomic gas like carbon monoxide can cause green house effect.

Recently, an international team of scientists has found a new, entirely unexpected green house gas (GHG) in the atmosphere. Known as trifluoromethyl sulphur pentafluoride (SF_5CF_3), the new GHG, that was spotted in the stratospheric air samples, is a potential infrared absorber-nearly 20,000 times as effective as CO_2.

The new GHG is an apparent newcomer in the atmosphere. The Antarctica snow samples show that till the late 1960s no trace of this gas was present in the atmosphere. At present, the concentration of this gas in the atmosphere is about 4 parts per trillion (ppt). The gas is presently growing by about 0.008 ppt per year or 6 per cent per year.

Nearly 3900 metric tons of the new GHG is currently present in the atmosphere. However, its concentration is progressively increasing due to the 270 metric tons of emissions regularly reaching the atmosphere every year. Although the amount of this gas currently present in the atmosphere is insignificantly small it has nevertheless a long lifetime of about 1000 years or more In contrast, CO_2 lasts only about a century in the atmosphere while methane is known to last for hardly a few decades.

The new GHG identified by the scientists is of exclusively anthropogenic origin, originating as a by product or breakdown product of sulphur hexafluoride (SF_6) gas which finds wide applications as an electrical gaseous insulator in switch gears, transformers, accelerators and a host of other high-voltage electrical/electronic equipments. Actually, the high-voltage discharge in such equipments creates SF_5 radicals. Such high-voltage systems, moreover, are likely to contain fluorepolymers which may possibly act as sources of CF_3 groups. The SF_5 radicals attack the CF_3 groups leading to the formation of SF_5CF_3 gas

Although at present the green house potential of the gas SF_5CF_3 is abysmally low, the scientists opine that is it important to constantly monitor the atmospheric concentration of this gas to guard against its undesirable accumulation in the atmosphere.

As already said, the green house gases have the consequence of causing the phenomenon of global warming. The global climate including rainfall, storms, wind patterns, ocean currents and sea levels may all be adversely affected due to this phenomenon.

The global warming may have the adverse effect of melting the polar ice caps and causing rise in the se a level leading to floods in the coastal areas.

Many computerised models have been used to study the possible effects of global warming. According to the predictions of one of these models, popularly called the circulation model, the global warming may drastically reduce the moisture levels in fertile zones turning many of them into deserts. On the whole, while some places may be affected by floods others may be hit by droughts.

The global warming may also affect the rainfall patterns and the onset of monsoon. This may have adverse consequences, particularly for an agricultural country like ours.

Thus, the warning bell is already ringing. something concrete has to be done to curtail the emissions of GHGs, especially CO_2, into the atmosphere. Otherwise, the perils of global warming may indeed work havoc on the life in this 'green' habitable planet.

High-Tech Surgery for Restoring Defective Vision

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India is increasingly becoming a country of the near-blind. This is no exaggeration, as the statistics reveal that one out of every four Indian needs vision correction. This correction can be achieved through spectacles, contact lenses or surgery. Some of us, instead of taking the best care of our eyes, end up with optical crutches. No matter how so for attractive the zars of the fashion world try to design spectacles, only the wearer knows it's not quite like the real thing. Pressure of the frame leads to eyestrain, headaches and unsightly marks on the nose. To put an end to this facial accessory, contact lenses have been introduced. These are small lenses that are placed directly on the cornea of the eye. But wearing contact lenses is not like wearing pair of shoes. Persons wearing lenses, soft or disposable, face problems. For example, some find the maintenance of lenses difficult while others have to face problems like infection. In addition, contact lenses are not always an ideal solution if the eyes or atmosphere are very dry.

Finally, we are left with surgery, but eye surgery is something every one is not comfortable with. Nevertheless, high-tech method like Lasik has made eye surgery increasingly safer, almost painless, riskless and quick. Lasik is an extension of the standard method known as PRK–which stands for 'Photoablative Refractive Keratectory; where a laser is used to modify the corneal curvature, that is, the angle of refraction. Laser, an acronym for light amplification by stimulated emission of radiation, is produced as a single coherent beam of light of precise wavelength, unlike ordinary light that is incoherent with many wavelenghts. PRK method employs a computer-controlled excimer laser beam to burn off minute sections of the cornea. It takes several hundred laser impulses to shape the cornea as desired to correct the visual defect. Unfor-tunately, this can damage the surface of cornea and lead to complications. These problems can be avoided by using Lasik which stands for 'Laser Associated In-situ Keratomileusis'. This technique also called Flap and Zap procedure, is a brilliant innovation of Pallikaris, an American scientist This method negates all the disadvantages of excimer laser and involves, correcting the corneal distortion by removing minute quantities of tissue from just below the surface of the cornea rather than from the surface itself, leaving the outer layer intact. Lasik laser procedure involves extensive computer analysis of the eye. After the computer analysis is complete, the spectacle or lens wearer is called for Lasik surgery Local anaesthetic eye drops are instilled in the eye to achieve a pain-free procedure. The patient is now asked to lie under the laser machine and fix his gaze at a blinking light. The data of the patient is fed into the computer memory of that laser A ring is then placed around the cornea which serves as a platform for the automated micro-keratome. With the help of a micro-keratome, a 160 micron flap (comparable to an onion skin) is picked up from the cornea. This flap remains attached at one end so that it can be flipped back like a lid afterwards. Laser is delivered to reshape the cornea to a desired curvature as in PRK This flap is now repositioned and allowed to dry for a few minutes where due to its intrinsic bonding properties it seals automa-tically. No stitches are required, as the hydration pressure in the eye is enough to seal back the surgical incision. The excimer produces a non-thermal light beam that eliminates the possibility of thermal damage to the surrounding tissues. Since in Lasik the corneal surface remains intact, there is far less scarring than with PRK. The entire procedure takes about ten minutes. The person has a good vision immediately after the procedure, and routine activities can be started the very next day. However, picking up a good corneal flap and repositioning it back requires greater surgical skill and the use of high-tech microkeratome machine increases the cost of the Lasik surgery. Lasik is ideal for people with Myopia upto 20, Hyperopia upto 8 and astigmatism upto 6 diopter. Minimum age requirements for undergoing this procedure is 18 years, though there is no upper limit for the same. Majority of the people get rid of their spectacles after Lasik surgery but a small percentage may have a mild variation from their targeted zero correction. In the past five years, Lasik method has been used to treat an estimate 500,000 people worldwide. A decisive factor for success is the surgeon's complete mastery of the complicated technique.

Recent high-tech surgical techniques have also solved the problem of retinal tear or detachment. The damage caused by tear or detachment can be controlled by simply sealing the hole or the tear by laser or cryopathy. In cases where the retinal detachment has already taken place, the surgeon restore to surgery. This involves scleral buckling, in which a surgeon sews a piece of silicon band or sponge over the site of retinal tear. This buckle supports the area till the laser or the cryopathy helps seal the tear. Another way is to inject an air bubble inside the vitreous cavity. After this process-called pneumatic retinoplexy—the patient has to keep his head in a specific position so that the bubble pushes the detached retina against the wall of the eye and disappears on its own. In complicated cases, vitreous surgery is performed to reattach the retina Here, the vitreous is removed through surgery and the eye is filled with a clear fluid compatible with the eye. Surface tension caused by the fluid or the gas pushes the retina back into position. Over a period of time, the fluid, or air is absorbed by the eye and replaced by its own fluids.

The most common cause of loss of vision in the old age is cataract, that is, gradual clouding over of the natural lens of the eye But the high-tech surgery has made the task of removing the cataract easy and painless. This is phacoemulsification surgery—a very big word that breaks up into phaco (Greek for lens) and emulsification (from Latin emugere, 'to milk out'). This is popularly called 'no stich' cataract surgery or 'drive-back' surgery in the west because the person operated upon can actually drive back to house right after the surgery. This technique leads to an early recovery and gives very rapid improvement of vision on the day one after surgery. The cataract is emulsified—that is, the clouded lens is broken up and drained away through an incision that is only 3.00 mm long. It is performed with an ultrasonic instrument with titanium tip that vibrates at a frequency of 40,000 times per second When the cloudy lens is all gone, a foldable posterior chamber intraocular lens is implanted through the same small incision. This incision is self sealing. This surgery has the advantage of no stitch, fast healing, minimum induced astigmatism and an early stabilisation of light refraction. Post operative complications are very rare. The procedure results in unaided vision and costs between Rs. 15000 to 20,000. Surgeons do not operate on both eyes together as even in the best hands, there is a 0.5-2 per cent chance of infection. Since the surgery involves the perforation of the globe, there can be bleed in some cases. But these risks are even higher in conventional surgery. The whole procedure takes 7-10 minutes. This technique is useful for all types of cataracts, except those which are very hard or hypermature. The equipment required for phacoemulsification is sophisticated and costly and surgeon needs more time to master the technique.

In India, due to high cost of phacoemulsification surgery cataract is still treated by conventional surgery, i.e intracapsular and extracapsular surgery. Intracapsular surgery is a 'large incision' technique. The clouded lens is removed and vision is restored by providing the patient with high powered spectacles In this case the patient has to wear very thick lenses and sees a world that is magnified and distorted like the images in a carnival fun-house mirror. This technique now has been abandoned in the industrialised world. In extracapsular surgery large incision is given to remove the clouded lens, however, the capsule that holds the lens is left in the original place. Then a tiny artificial lens is implanted. The intraocular transplant restores distortion free vision without the heavy specs — but it requires lot of cutting and stitching. Seven to nine stitches are given and the patient needs as long as two months to regain sight.

Though we have taken big strides in the field of technology yet the fact remains that with existing infrastructure we are able to cater only fraction of what the demand is. Above all, due to heavy costs, not too many patients are encouraged to go for high-tech medical intervention It is hoped high-tech innovation will become cheaper in coming time and within the reach of common man.

Inquiry for the Science Laboratory Effectiveness of Secondary Schools*

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The useful activities for science education, namely science fair, science exhibition, visits, and science tours are considered to be an integral component of science education. But the place of science laboratory of the secondary school is unique as far as science education is concerned. The science laboratory can wait for its proper student but the students cant' wait for appropriate science laboratory. Hence, there should be a bridge between the student and science laboratory.

As Jawaharlal Nehru the first Prime Minister of India has said, "No country can be prosperous without the development of Science and Technology", it is necessary to develop science and technology to make the free India, rich and prosperous. And now, in the 21st century, there is no doubt that the development of science and technology will be an unavoidable pre-requisit for the development of any nation It is in this reference that it is necessary for every citizen to practice science and technology in his/her daily life. It is a fact that the children of today are the future of tomorrow, so, now it is a must to educate every child by giving him/her proper education in science and technology. This will help to develop the scientific insight in his/her daily life. Besides this, the principles of science are verified in the science laboratories. If the learners of the secondary level in schools develop the skills of using science and technology and apply them in their daily life, their scientific attitude will be built. The science laboratories in schools can play a crucial role in this endevour If the learners are trained in science and technology with adequate hands on experiences in the laboratory, they can solve their personal problems in a scientific way and as trained citizens of the nation, they can also understand the problems of the nation. Thus, the school laboratories are at the root of the development of science and technology. For this reason, the school laboratories should be well equipped. It is interesting to know about the effectiveness of science laboratories of the secondary schools.

In the science laboratory - planning, arrangement, and utility are the strong aspects. If they are in appropriate order, the science laboratory will be effective. So, the inquiry about the science laboratory effectiveness of the secondary schools, and to study the relationship between science laboratory effectiveness

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of secondary schools with reference to (1) planning, (2) arrangement, (3) utility is necessary.

Objectives of the study

1 To develop a Science Laboratory Effectiveness Questionnaire (SLEQ).

2 To validate the tool (SLEQ) Using the Rasch model of item response theory (IRT).

3. To inquire about the science laboratory effectiveness of the secondary schools, to study the relationship between science laboratory effectiveness of secondary schools, and (1) planning, (2) arrangement, and (3) utility

Hypotheses

To check the invariance of item and person parameter estimations, the following hypotheses were formulated:

1 There will be no difference between the mean Rasch Partial Credit Model (RPCM) item estimates on the SLEQ.

2. There will be no difference between the mean RPCM person estimates on the SLEQ

3. There will be no significant difference between the mean scores of the rural and urban area at the level of planning on the science laboratory effectiveness questionnaire of secondary schools.

4. There will be no significant difference between the mean scores of the rural and urban area at the level of arrangement on the science laboratory effectiveness questionnaire of secondary schools.

5. There will be no significant difference betwwen the mean scores of the rural and urban area at the level of utility on the science laboratory effectivencess questionnaire of secondary schools

Method

Descriptive, survey method was applied to the research.

Research area

Science education.

Population and the sample

The sample of the survey was consisted of 200 science teachers from 200 secondary schools of Bhavnagar District of Gujarat state (in A.D. 1999). There were 588 science teachers in the popultion which is shown in Table 1.

The senior science teachers who were incharge of science laboratory, were selected for the sample.

Tool

The self made questionnaire — Science Laboratory Effectiveness Questionnaire (SLEQ) was applied to examine three dimensions affecting the secondary school science laboratory viz ; planning, arrangement, and utility including the fitness of the tool was inquired with the Rasch Model of Item Response Theory.

The test consisted of 32 questions to be answered in 'yes' or 'no' pertaining to the three dimensions of the study, namly, planning, arrangement, and utility. Questions from 1 to 14, 15 to 24, and from 25 to 32 were in respect to these aspects in that order. Each item (question) of the questionnaire was

TABLE 1

Population and Sample of the study

Taluka	*No. of schools from rural area*	*No of schools from urban area*	*Total no. of schools*	*Total no. of science Teacher (Popu.)*	*Total no. of (sample) science teacher*
1. Bhavnagar City	-	44	44	182	44
2. Bhavnagar	07	09	16	35	16
3 Botad	07	11	18	47	18
4. Gadhada	06	06	12	36	12
5 Gariyadhar	06	11	17	45	17
6. Ghogha	03	05	08	12	08
7. Mahuva	12	13	25	90	25
8. Palitana	06	09	15	38	15
9. Sihor	07	07	14	43	14
10 Talaja	07	05	12	25	12
11. Umarala	04	05	09	19	09
12. Vallabhipur	05	05	10	16	10
Total	**70**	**130**	**200**	**588**	**200**

assigned as score of 0, 1 points depending on the response ('no', 'yes').

Pilot study

The sample for the pilot study of 22 science teachers working in 22 different secondary schools, out of 30 Gujarati medium secondary schools of Bhavnagar District, was selected randomly. In the sample 12 teachers were B.Sc , B.Ed. and 10 teachers were M.Sc , B.Ed. They were incharge of science laboratories There were 13 male teachers and 09 female teachers in the sample Among them, 2 teachers were having 2 years teaching experience, 4 teachers having 5 years, 6 teachers having 10 years, and 10 teachers having more than 15 years teaching experience. 12 of them were working in rural area while 10 teachers were working in urban area.

Fitness of the tool

A person by item matrix, containing 704 (22 person 32 items) data points was prepared.

The major part of analysis of the data in the pilot study was carried out by the computer programme CREDIT 2 on a personal computer. CREDIT 2 analysed the data using the Rasch Partial Credit Model (RPCM) of item response theory (IRT).

The CREDIT 2 based analysis included the calculations for item and person parameter estimates, standard errors of item and person parameter estimate, item and person fit statistics, score quevalence table, item probability plots (i.e. item characteristics curve - ICCs), and item information plots.

The standard error, item information plots, and item information indices were used for analysing the data.

Item parameter estimation

The estimation procedure implemented by the programme CREDIT 2 is a generalization of the UCON procedure described by Wright and Stone (cited in Joshi, 1996) for the dichotomous Rasch Model.

Person parameter estimation

The computer programme CREDIT 2 provided individual results in items of raw scores, person parameter — ability estimate (logit), standard error of ability estimate and a statistic summarizing the fit to the model for each teacher of the sample (pilot-study) of 22 for the present tool. These individual results in terms of means, and standard deviation (SD) were calculated.

Data collection

The data on the subject i.e. science laboratory effectiveness was collected on the questionnaire (SLEQ), Prepared by the investigator. First of all the researcher had taken the permission of the sampling schools for the data collection. After taking permission the researcher had personally gone to the teachers of each sample school and gave them the detailed information and got the questionnarie filled by them. Individual information was taken along with the questionniare, there were different variables like the educational qualification, gender, rural or urban area.

Method of data analysis

After getting questionnaire filled by the respondents, scoring was done as per the method described for the pilot-study. The data was arranged according to the pre-requirements of analysis.

For the inquiry of the science laboratory effectiveness, mean and SD were used. To examine the significant difference between the rural and urban area at the secondary schools, the mean scores and t-test were applied.

Conclusions

The conclusions of the study were as under

1 The conclusion of the total sample, which includes 200 science laboratories, shows the middle level of effectiveness

   The mean of total sample was 18.82 shows a middle level of effectiveness of the science laboratories. It can be said that secondary schools of Bhavnagar District do not score high on effectiveness for the science laboratories

2. There was no significant difference in the mean scores of science laboratory effectiveness between the rural and urban secondary schools of Bhavnagar District.
3. There was no significant difference in the mean scores of the level of planning on the science laboratory effectiveness between rural and urban secondary schools of Bhavnagar District.

4. There was no significant difference in the mean scores of the level of arrangement on the science laboratory effectiveness between rural and urban secondary schools of Bhavnagar District.
5. There was no significant difference in the mean scores of the level of utility on the science laboratory effectiveness between rural and urban secondary schools of Bhavnagar District.
6 There was significant difference at 0.01 level in the mean scores of the level between planning and arrangement on the science laboratory effectiveness of secondary schools of Bhavnagar District.

There was significant difference at 0.05 level in the mean scores of the level between arrangement and utility on the science laboratory effectiveness of secondary schools of Bhavnagar District.

There was significant difference at 0.05 level in the mean scores of the level between utility and planning on the science laboratory effectiveness of secondary schools of Bhavnagar District

The level of planning shows high level of mean scores. The level of planning was more effective than arrangement and utility on the science laboratory of secondary schools Besides, the level of arrangement was more effective than utility.

Suggestions

After the analysis of the data and examining the results of this research project, the researcher wishes to give the following suggestions.

1. The results of this research shows that the laboratories of secondary schools of Bhavnagar District have middle level of effectiveness in respect of the dimensions like planning, arangement, and utility of laboratories. So the researcher suggests that secondary schools must be provided facilities and impetus to acquire a high level of effectiveness for the science laboratories with respect to these three dimensions.
2. It is observed that the science laboratories of rural and urban secondary schools had no significant difference in effectiveness. So management of urban secondary schools must provide facilities of modern science laboratories.
3. If the suggestions of science teachers are considered in the decision concerning Improvement in the effectiveness of science laboratory, they are likely to be more effective and would work better for utility. Thus, their partnership in the decision making in planning for the science laboratory is necessary.
4. After knowing the level of factors planning, arrangement, and utility affecting the effectiveness of science laboratory, suitable planning, arrangement, and utility should be used and the secondary laboratories should be well equipped.

Educational implications

Secondary schools of Bhavnagar District had not high effectiveness for the science laboratories. It shows middle level of effectiveness This is not a good situation The science laboratories are at the root of the development of science and technology. For this reason, the school laboratories should be well effective. There is middle level planning, arrangement, and utility at the science laboratories of secondary schools of Bhavnagar District. Arrangement and Utility are poor dimensions of them. Many schools had not proper arrangement and utility of science laboratories We can say that, unless the student will get appropriate amount of practice in science laboratory, he/she will face difficulties in developing science learning, If the science teacher will get appropriate science laboratory, he/she will teach effective science education

We can suggest that the secondary science education should be more important Effective science laboratory is more useful in science education. So, efforts for the effectiveness of science laboratory should be created by the management.

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Isolation and Control of Variables by the Biology Teachers

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For quite a long time, science had been defined a *'systematized body of knowledge'*. Many teachers / teacher educators even today cling to this definition of science. Of late, science has been considered as a way of thinking and behaving and it is process and product simultaneously. In fact, true science, resides in its modes of inquiry. There are rather no set steps for the inquiry modes of knowing. 'Actually there is no one method that characterizes science' (Hurd, 1970). Concept of *'the scientific method'*, therefore, is a figment of understanding it

Experimental thinking is essentially tagged to processes of inquiry modes. The following mental functions chiefly constitute the processes of science: Observation; measurement; inference; prediction; formation and testing of a hypothesis; making of interpretations and/or mental models of scientific reality, etc Testing of a hypothesis needs creation of an experimental setting True experimental design, depends on injecting a control group into the inquiry procedures. Isolation and control of variables form a necessary link in an experimental study This provides determining / establishment of cause and effect relationship between and among the independent and dependent variables.

Inquiry-curriculum theorists emphasize understanding of science instead of inventorying its achievements. Inquiry modes of sciencing provide interactions in building processes as well as in development of higher order conceptualizations. In order to develop/ nurture experimental thinking related to isolation and control of variables among the students, it seems desirable, first to assess this ability in postgraduate biology teachers, so that in case of its deficiency, in-service orientation programmes can be planned.

Sample

Twenty postgraduate biology teachers of Kendriya Vidyalayas participated in this study. They had come to Regional Institute of Education, Bhopal to attend an orientation programme in biology during the month of June 2001. Their teaching experience varied from five to fifteen years.

Assessment measure

The following task was adapted (Driver et. al., 1982) to assess sampled teachers' ability to isolate and control of variables.

A house wife lodged some plants of the same species and having same type of soil in pots on the window-sill. Each day she watered them and a little liquid fertilizer was also added.

After few days, all the plants began to wilt. She became interested to know why did the plants wilt. She then produced the following pots:

A . Water and fertilizer as before;

B : Water as before, no fertilizer;

C : Less water than before, fertilizer as before;

D : Less water than before, more fertilizer than before; and

E . No water, no fertilizer

Which two pots (A to E) she needs to select, to find out, if the plants-

(a) wilted because of two much water ?

(b) wilted because of the fertilizer?

(c) were helped to grow because of the fertilizer?

Scoring

Driver et. al., (1982) have suggested that each correctly isolated and controlled variable be awarded a score of one. Therefore, a subject could earn a maximum score of 3. Right answers were

Question (a) . A and C

(b) . A and B

(c) : C and D

Question (a)

It deals with the isolation of the effect of too much water that caused wilting of the plants. None of the sampled teacher selected the right choice of pots of A and C. Eight types of wrong choices were exercised by them in order of A/B 45%, B/C 20%; B/D 10%; and 5% each of A/E, B/E, C/D; B; and no response. Therefore, all the teachers selected wrong choices of variables.

Question (b)

It is related to isolation of fertilizer as a variable that caused wilting of the plants. Only two teachers (10%) selected right choice of the pots of A and B. On this task as well, these teachers exercised 8 kinds of wrong choices. They were C/D 40%, 10% each for B/E; D and no response. 5% each choice was B/C; B/D; D/E; C; and D. Wrong choices, therefore, were selected to the tune of 90% for this task.

Question (c)

For this question, the effect of fertilizer had to be isolated that promoted plant's growth 15% of these teachers selected right choices of C and D pots. The rest of them (85%) selected 11 wrong choices of variables. 15% each selected A/B; and A/C variables. 10% each choice was made for B/C and D. While 5% each choice was exercised for A/D; A/E; B/E; D/E, and A; B; and no response. On this task, 5% increase had been registered over task (b) for the correct answer. At the same time number of choices had as well increased by 3(15%) more wrong choices.

Further analysis of the data revealed the following interesting observations.

(i) None of the Ss scored three marks, i.e. not a single teacher was able to isolate and control variables related to all the three questions. This is as well true for questions a/b; a/c; and b/c;

(ii) 85% of these teachers failed all the three administered tasks; and

(iii) An unusually very high per cent of them failed on all the three tasks (100, 90, and 85, respectively).

Discussion

Construction of knowledge does not depend on perceptions and/or on sensations alone. Hence, it is asserted that proper understanding of biological concepts does not result due to S-R connections or by listening to teacher transmitted textbook information. Conceptual change takes place when open searching is done in the form of hypothesis creation and its experimental testing that embraces isolation and control of variables. This ability according to Piagetian (1950) theory of cognitive development banks on hypothetico-deductive reasoning of the learners. Biology/Chemistry postgraduate teachers of JNV's had been found deficient in negotiating Piagetian early formal reasoning, spatial visualization, and co-ordination of horizontality and verticality tasks (Pachaury, 2000). Therefore, the sampled teachers' (KVS) extremely poor performance on higher order thinking tasks like isolation and control of variables does not at all surprise the experimenter.

Extremely bad performance of these teachers, seems to be related to their learning experiences and socially approved values about its teaching in the schools. This all reinforces their strong liking for imparting content-based biology information to senior secondary students, so that they register its better achievement in the board's examination. Another probable cause for this state of affairs is tagged to an incipient sinistral swing in favour of conceptual structure of the sciences. Consequently, this new venture in teacher education programmes, led to a covert apathy for science of learning by the children. Year after year, this tendency flourished like toadstools and kept on dictating in-service orientations in favour of course-contents only.

The results of this study strong support the contention that these sampled teachers need orientations in process-based biology instruction. Equipping them in how to plan and conduct bio-experiments (isolation/control of variables) would help them in nurturing process skills of their students. It is opined that process-based learning of biology by the students would improve their ability and attitudes to behave in a more responsive manner as consumers of our depleting biological resources. Some of them might as well create new knowledge and better bio-technology for the well being of the mankind harbouring this planet.

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Mathematics and Logic

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Mathematics belongs to every inquiry, moral as well as physical. Even the rules of logic, by which it is rigidly bound, could not be deduced without its aid. The laws of argument admit of simple statements, but they must be curiously transposed before they can be applied to the living speech and verified by observation. In its pure and simple form the syllogism can not be directly compared with all experiences, or it would not have required Aristotle to discover it. It must be transmuted into all possible shapes in which reasoning loves to clothe itself. The transmutation is the mathematical process in the establishment of law." — Peirce, Benjamin.

Logic is the scientific study of conditions of accurate thinking and valid inferences. Mathematics is the only field of knowledge in which logical laws can be applied and the results verified by independent means. Mathematics, in general, is described as deductive science and in every piece of deduction, there are three parts i.e., premises, the process of reasoning and conclusion. The laws of deductive thought are applied to the premises in order to get the conclusion. The idea of reducing mathematics to logic was expressed by G. Leibnitz (17th Century). The practical realization of the thesis of logician was undertaken at the end of the 19th Century and the beginning of 20th Century by G. Frege and B. Russel.

The axiomatic approach to logic was first propounded by George Boolean Englishman. On this account logic relevant to mathematics is sometimes called Boolean Logic. It is also called mathematical logic or more recently symbolism. With the advent of computer and the study of language in the context of computers, symbolic logic has gained added importance. It is worth mentioning the thought of Leevre Arthur, "Formal thought consciously recognized as such, is the means of all exact knowledge; and a correct understanding of the main formal sciences, logic and mathematics, is the proper and only safe foundation for a scientific education."

Logic deals not only with facts but with relations of statements. Relations or connectives are expressed by symbols but these symbols are not static. For instance, '+' sign used in chemical equation does not mean numerical addition of the quantities. The symbol '-' (minus) sometimes means subtraction and other time means direction. It is by extension of meaning of symbols, that it becomes possible to economise thought not only in mathematics but also in other sciences. It was found that most of the mathematical symbols could be generalized still further so that they could be applied to logical propositions also.

The aim of the mathematician is to place his science on sure foundation. His aim is to prove every proposition with the help of those propositions that have already been proved and to define every word with the help of those words that have already been clearly defined. If this is the aim, mathematician wants to reduce the number of undefined proposition and undefined words as small as possible Therefore, it becomes necessary for him to investigate into the conditions of valid inferences what is called the science of logic. Therefore, ultimately, the investigation into the foundations of mathematics become an investigation into the laws of thought.

Laws of Statements and Logical Connectives

One of the difficulties in analyzing mathematical rigour and proof is the fact that we must communicate our ideas to each other in an ordinary language All such languages are full of ambiguities, words have multiple meanings, some meanings are very vague and it is sometime difficult to decide whether or not a given line of reasoning is acceptable. One of the goals of logic is to eliminate these ambiguities by making it clear just how statements are to be constructed, evaluating the concept of truth, and establishing specific rules of inference by which a given argument may be judged as valid or invalid

Thus, logic is a broad subject, dealing with methods of producing valid arguments. In developing deductive methods and criteria for judging the validity of arguments, logicians have found it necessary to consider the various ways in which one reasons naturally and extracting those procedures which are good and eliminating those which are not.

The derivable objects of logical calculus are interpreted as statements, formed from the simpler ones by means of propositional connectives and quantifiers. In the context of logic, a statement means a declarative sentence conveying a situation which is neither imperative, interrogative nor exclamatory. Any statement is assumed to be either true or false, or equivalently either valid or invalid. A statement can't be both true and false at the same time. True or false is said to be the truth value of any statement denoted by the symbols T and F respectively.

A statement is said to be **simple** if it does not depend on another statement. For instance.

(i) New Delhi is the capital of India.

(ii) The set of natural numbers is infinite.

Compound Statement is a combination of two or more simple statement. For example:

(iii) $\sqrt{2}$ is an irrational number **and** $^1/_2$ is a rational number.

(iv) The school runs **or** a holiday is declared.

(v) **If** it is Sunday, **then** office may be closed.

(vi) Sum of real numbers a and b is a rational number **if and only if** a and b are rational numbers.

(vii) All triangles are not isosceles.

In all the above cases, statements are obtained by combining or connecting two simple statements. The phrases or words connecting two simple statements are called logical connectives. Thus, as mentioned above in bold letters, 'and' symbolised as ^ (conjunction); 'or' as v (disjunction); '→' stand for conditional; 'if.. then . .'; ↔' for biconditional if and only if; ~ symbol for negation 'Not' are all logical connectives. These connectives assume the values true or false in accordance with the laws defined in tabular forms for each connective.

Truth table of operation ∧ (Conjunction)

Let P and Q be any two statements, then intuitively we feel that P∧Q ought to be true if both P and Q are true, otherwise the truth value of P∧Q has truth value F (False) as expressed in the tabular form.

Table: 2.1

P	Q	P∧Q
T	T	T
T	F	F
F	T	F
F	F	F

Truth table of operation ∨ (disjunction)

Let P and Q be any two statements, then the compound statement P∨Q which means "P or Q or both". In mathematics, we use the word or in the inclusive sense. The disjunction is a case where our intuitive understanding of the connective will be quite adequate to tell us how to make logical definition of the truth value of compound statement as indicated below.

Table 2.2

P	Q	P∨Q
T	T	T
T	F	T
F	T	T
F	F	F

Truth table of operation ~ (negation)

A statement which is modified by the word 'not' is called the negation of the given statement. For example, consider the statement, "Roses are red in colour". Its negation is, "Roses are not red in colour". Generally, in the case of simple as well as compound' statements, the phrases, "It is not the case" or "It is false that" are used to express the negation of the statement. For example, consider the statement, "Roses are red in colour and sky is blue in colour". Its negation is, "it is not the case that roses are red in colour and the sky is blue in colour" or "It is false that roses are red and the sky is blue" It is reasonable to define the truth value of negation as given in the Table 2.3.

Table 2.3

P	~P
T	F
F	T

Truth table of the Connective → ("If... then ...")

The motivation for the truth value assignment for the conditional statement is the fact that as intuitively understood P→Q is true if Q is deducible from P in some way. Thus, iff P and Q are both true, we want the implication P→Q to be true and if P true and Q false, we want the implication P→Q ought to be false. Moreover as per the common sense, one may argue that P→Q is not applicable whenever P is false. However, in the logical system, we assign truth value to P→Q whenever P is false independent of truth value of Q. For the appropriateness of truth value assignment to P→Q where P is called antecedent and Q termed as consequent of the conditional, let us cite the following example:

Example: Mohan made a promise stated as : "If I get L.T C I shall take my family on journey."

This conditional statement has two parts

P: If Mohan gets L T.C. (antecendent)
Q: He will take his family on journey (consequent).

We get verbal translation of Mohan's promise symbolically as P→Q. To assign truth values to his assertion, let us analyse the following situations.

(i)	P is true; and Q is true	Then Mohan's assertion is true.
(ii)	P is true; and Q is false	Then Mohan is not keeping his words hence his assertion is false.
(iii)	P is false; and Q is true	Then the implication convey the meaning that Mohan is keeping his promise even though he does not get L.T.C. Thus his assertion should be treated true.
(iv)	P is false, and Q is false	This assertion is also consistent with his promise in negative sense and hence his assertion in this case too should also be taken true.

From the above discussion, it is inferred that P→Q has truth value T if P has false value independent of truth values of Q. Thus we define the truth value assignment for the implication P→Q as follows:

Table 2.4

P	Q	P → Q
T	T	T
T	F	F
F	T	T
F	F	T

If P→Q and Q→P, then we say that statements P and Q are logically equivalent expressed through biconditional connective as $P \leftrightarrow Q$ which amounts to the statement pattern $(P \to Q) \wedge (Q \to P)$ yielding to the truth value assignment for logical connective (iff) as follows:

Table 2.5

P	Q	$P \to Q$	$Q \to P$	$P \leftrightarrow Q[(P \to Q) \wedge (Q \to P)]$
T	T	T	T	T
T	F	F	T	F
F	T	T	F	F
F	F	T	T	T

Note: From a given conditional several other conditionals may be constructed by rearranging or negating the terms. For example, by interchanging the antecedent and consequent of $P \to Q$, converse invariant $Q \to P$ is obtained. By negating antecedent and consequent of $P \to Q$, inverse variant $\sim P \to \sim Q$ is derived. Another variant $\sim Q \to \sim P$ called contra positive is obtained by negating and interchanging the antecedent and consequent Whenever a conditional $P \to Q$ and its converse $Q \to P$ are both true, the statements P and Q are said to be equivalent as mentioned earlier.

Tautology and Contradiction

Any logical expression involving logical variables termed as statements P, Q, .. and logical operations or connectives is called proposition. Any proposition **t** is called a tautology if it always assumes the truth value T independent of truth values of component statements or logical variables P, Q, ... Analogously, a proposition **c** is called contradiction if it is false for any truth values of its variables P, Q, ... For example $P \vee \sim P$ is a trautology **t** where as $P \wedge \sim P$ is a contradiction **c** since in the respective last column of their truth tables, truth values T and F occur as shown in the Table 3.1.

All tautologies are true by the virtue of their logical structures and their truth value are independent of truth values of component statements. Tautologies are of utmost importance in drawing conclusions. When the number of sentential variable is small, a truth table may be used to prove easily whether or not a statement is a tautology. The proofs consist simply of constructing the truth table and noting whether the statement has truth value T for all combinations of truth values. Similar is the case with contradictions.

Table 3.1

P	$\sim P$	$P \vee \sim P \equiv t$
T	F	T
F	T	T

and

P	$\sim P$	$P \wedge \sim P \equiv c$
T	F	F
F	T	F

Example 3.1 $\sim P \vee Q \rightarrow [P \rightarrow Q] \equiv \mathbf{t}$(tautology)

Table 3.2

P	Q	$\sim P$	$\sim P \vee Q$	$P \rightarrow Q$	$\sim P \vee Q \rightarrow [P \rightarrow Q]$
T	T	F	T	T	T
T	F	F	F	F	T
F	T	T	T	T	T
F	F	T	T	T	T

Example 3.2 $(\sim P \vee Q) \wedge (P \wedge \sim Q) \equiv c$ (Contradiction)

Table 3.3

P	Q	$\sim P$	$\sim Q$	$\sim P \vee Q$	$P \wedge \sim Q$	$\sim P \vee Q \wedge (P \wedge \sim Q)$
T	T	F	F	T	F	F
T	F	F	T	F	T	F
F	T	T	F	T	F	F
F	F	T	T	T	F	F

It is interesting to remark that the negation of any tautology is a contradiction and the negative of any contradiction is a tautology i.e. $\sim t \equiv c$ and $\sim c \equiv t$.

Algebra of propositions (Statements)

To simplify a proposition, one must find another proposition having a simple form in the sense of involving fewer connectives, yet equivalent to the given proposition. We mention below some laws which provide a technique enabling us to construct another equivalent proposition from the given proposition. If P, Q and R are any propositions or statements, then

Commutative Laws

(i) $P \vee Q \equiv Q \vee P$

(ii) $P \wedge Q \equiv Q \wedge P$

Associative Laws

(i) $(P \vee Q) \vee R \equiv P \vee (Q \vee R)$

(ii) $(P \wedge Q) \wedge R \equiv P \wedge (Q \wedge R)$

Distributive Laws

(i) $P \wedge (Q \vee R) \equiv (P \wedge Q) \vee (P \wedge R)$

(ii) $P \vee (Q \wedge R) \equiv (P \vee Q) \wedge (P \vee R)$

Idempotent Laws

(i) $P \vee P \equiv P$ (ii) $P \wedge P \equiv P$

Identity Laws

(i) $P \vee c \equiv P$

(ii) $P \wedge t \equiv P$ where t and c stand for tautology and contradiction respectively.

Negation Laws

(i) $P \wedge (\sim P) \equiv c$

(ii) $P \vee (\sim P) \equiv t$

(iii) $\sim(\sim P) \equiv P$

Absorption Laws

(i) $P \wedge (P \vee Q) \equiv P$

(ii) $P \vee (P \wedge Q) \equiv P$

Null Laws

(i) $P \wedge c \equiv c$

(ii) $P \vee t \equiv t$

Demorgan's Laws

(i) $\sim(P \vee Q) \equiv (\sim P) \wedge (\sim Q)$

(ii) $\sim(P \wedge Q) \equiv (\sim P) \vee (\sim Q)$

Note: For the assimilation of above stated laws, one should take into account algebra of sets since the statement-laws are akin to set theoretic properties by interpreting the symbols ~, ∨, ∧ as complementation, union and intersection respectively, and furthermore, by identifying statements with subsets of universal set, tautology **t** with universal set and contradiction **c** with empty set.

Application of Logics to Switching Networks

The symbolic logic discussed above has unexpected and powerful application in the designing of the switching networks. A switching circuit is a connection of a finite number of switches. There are only two possibilities for any switch i e., it is either 'On' or 'off'. Complicated network can be constructed by joining together two ore more given networks in parallel or series. In the logical framework, switches S_1 and S_2 are, connected in parallel are expressed symbolically by $P \vee Q$ and if switches S_1 and S_2 are connected in series, it is expressed by the statement pattern $P \wedge Q$ where statements P and Q are assigned to the switches S_1 and S_2. Thus following circuit (Fig. 5.1) having switches S_1 S_2 connected in parallel i.e., has symbolic representation $P \vee Q$ whereas the circuit with switches S_1 and S_2 connected in series (Fig. 5.2), has symbolic representation $P \wedge Q$.

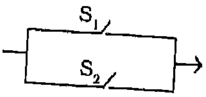

Fig. 5.1

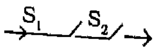

Fig. 5 2

Furthermore, if we represent two switches by S_1 and S_1', then it implies that S_1' is 'On' whenever S_1 is 'Off' and S_1' is 'Off' whenever S_1 is 'On'. We also agree not to distinguish between two switches which are simultaneously 'On' or simultaneously 'Off' and ascribe the same letter to them as in Fig. 5.5.

Example 5.1 Consider the following circuit diagram involving three switches S_1, S_2, S_3 i.e.,

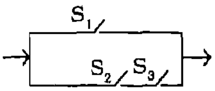

Fig. 5.3

Let us assign statements to these switches as follows·

P · Switch S_1 is 'On'
Q : Switch S_2 is 'On'
R : Switch S_3 is 'On'

This network has symbolic representation $P \vee (Q \wedge R)$

Using distributive law we have

$P \vee (Q \wedge R) \equiv (P \vee Q) \wedge (P \vee R)$ yielding another network expressed as

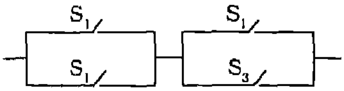

Fig. 5.4

Example 5.2 Consider another circuit network involving five switches i.e.,

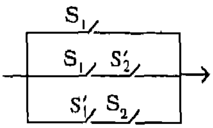

Fig 5.5

Let us make the following logical arrangement

P : Switch S_1 is 'On'
Q · Switch S_2 is 'On'
~P · Switch S_1 is 'Off' i e., Switch S_1' is 'On'
~Q : Switch S_2 is 'Off' i.e , Switch S_2' is 'On'

We have the following symbolic representation of the network i.e.,

$$P \vee (P \wedge \sim Q) \vee (\sim P \wedge Q)$$

simplifying, we get

$P \vee (P \wedge \sim Q) \vee (\sim P \wedge Q)$

$\equiv [(P \vee P) \wedge (P \vee \sim Q)] \vee (\sim P \vee Q)$

D (Distributive Law)

$\equiv [P \wedge (P \vee \sim Q] \vee (\sim P \wedge Q)$

(Idem potent Law)

$\equiv (\sim P \wedge Q) \vee [P \wedge (P \vee \sim Q)$

(Commutative Law)

$\equiv [(\sim P \wedge Q) \vee P] \wedge [\sim P \wedge Q) \vee (P \vee \sim Q)$

(Distributive Law)

$\equiv [P \vee (\sim P \wedge Q)] \wedge [(\sim P \wedge Q) \vee \sim (\sim P \wedge Q)$

(Demogarn's Law)

$\equiv P \vee (\sim P \wedge Q) \wedge \mathbf{t}$ (Negation Law)

$\equiv P \vee (\sim P \wedge Q)$ (Identity Law)

$\equiv (P \vee \sim P) \wedge (P \vee Q)$

(Distributive Law)

$\equiv \mathbf{t} \wedge (P \vee Q)$

(Negation Law)

$\equiv P \vee Q$

Thus, finally earlier complicated circuit (Fig. 5.5) involving five switches gets simplified equivalently into simpler one containing two switches only as given in Figure 5.6. Reduction of number of switches to obtain an equivalent circuit is called **simplification** of the circuit as expressed below:

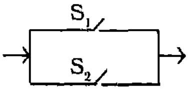

Fig. 5.6

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Pain : Unsolved Mystery

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There is considerable controversy and lack of knowledge about how a stimulus is transformed into an awareness of pain. The anatomy and physiology involved in the reception, transmission, and perception of pain are extremely complex. All pain is interpreted as such in the brain. Pain cannot exist unless impulses reach the higher cortical centres of a conscious individual. An unconscious person does not have pain. Brain identifies the existence and location of pain. Since anxiety, depression, and other emotions usually accompany pain, it is almost impossible to say whether the physiological manifestations reflect the emotions or the pain. Hence, sufferings like pain defies definition and can be subjective. Experience of pain usually occurs in three phases. (1) anticipation of pain, (2) sensation (or presence) of pain, and (3) the after aftermath of pain. All three phases may occur in a matter of seconds, or they may extend over a period of years. These phases may also occur in cycles over a period of hours or years. Certain characteristics of pain have been universally recognized as being important to assess: location, intensity, quality, onset, duration and variations. But, it is difficult to quantify these characteristics.

Although many exciting discoveries relating to pain have been made, the route by which impulses arrive in the brain is very complex and still not entirely known But Melzack and Wall-gate-control theory is a successful attempt in this direction. According to this theory, transmission of pain impulses can be modulated by gating mechanism all along the central nervous system i.e. when the gate is open, pain impulses flow through easily: when the gate is closed, no pain impulse flows, through; when the gate is partially open, only some of the pain impulses flow through. Gate theory established that pain is not just a physiological function of tissues, but that psychological variables interact to influence the perception of pain in intensity and quality. Hence pain be made more tolerable by placing the sensation on the edge of awareness rather than at the centre of attention. Thoughts and feelings generated by the circumstances surrounding episode of pain can also influence the gating mechanism.

The pH in the tissue in pain state is highly acidic. The acid metabolites seem to heighten the sensitivity in pain fibres. The acid metabolites are algogenic, capable of provoking pain. They include histamine, kinnins, prostaglandins and serotonin. Pain relieving action of aspirin and other non-narcotic analgesics is due to the blocking of acid metabolite production e.g. prostaglandins. In addition to this, both stress and pain are known to activate endorphin release.

But it is not known to what extent pain intensity triggers endorphin release. Endorphin is a complex of two words, endogenous and morphine, meaning a 'morphine within', morphine being a potent narcotic analgesic. In some people anxiety about their pain releases endorphins hence they may be less sensitive to pain. Pain relieving action of acupuncture as well as low frequency transcutaneous electrical stimulation is also mediated through endorphin release In chronic pain, endorphin system apparently ceases to function.

Pain is classified according to location as superficial deep-somatic and referred pain Superficial or cutaneous pain usually refers to pain in the skin and mucous membranes. Pain in superficial tissues can be identified fairly easily and precisely by the patient because of its innervation. Deep somatic pain refers to pain which involves deep structures other than viscera e.g. periosteum, muscles, tendons, fascia and joints. Referred pain may be difined as pain which is present in an area that is removed or distant from its point of origin. Referred pain most commonly in referred from viscera to parietal region.

In clinical practice the patient's pain is either called psychogenic or somatogenic. Somatogenic pain usually is defined more in physical terms referring the physiological processes involving the somatosensory system Psychogenic pain, on the other hand, usually implies that the pain originate in the mind, that is, it is a somatic delusion. However, Davis (1980) held that the dichotomy between psychogenic and somatogenic pain is an artificial one because 'all perceptual experience has a physiological basis and all physiological stresses have psychological effects! 'Pure' organic pain, pain sensations that result only from physical stimuli, are as unlikely as 'pure' psychogenic pain. As soon as pain occurs, and at times before, emotions such as anxiety, anger, or depression arise to influence the total pain experience. It is very difficult to authenticate and legitimize the presence of the patients's pain Proving the presence of pain is so problematic that physicians continue to seek a procedure in laboratory tests that will differentiate between so-called organic and psychogenic pain. Even though physical stimuli for the pain may be absent in psychogenic pain, the emotional stimuli are present and they are conveyed by physiological mechanisms to the level of consciousness or awareness along the nervous system. The location, severity and other qualities of psychogenic pain can be exactly like those of somatogenic pain. Hence psychogenic pain is not simply grief or some other unpleasant emotional experience. In chronic pain patients even psychogenic pain processes start with a 'genuine' organic process. Hence the results of both research and clinical observations regarding mental processes and emotional states associated with pain are not only inconclusive, but in some cases contradictory.

Attempts have also been made to differentiate persons suffering from pain as 'pain patient', 'painful patient', 'pain prone patient' and 'painful family' Pain patients refer to those who present themselves to doctor with a complaint of pain, seeking relief from it. Painful patient is one whose humanity is intimately related to, or wholly dependent upon his being in pain and suffering Pain-prone patient is a person who suffers repeated or prolonged pain. In these persons, patients's own special personality affects his experience of pain in complicated ways and organic pathology underlying pain very often is identifiable as a child abuse Painful families are families in which one or both parents, more frequently the mother, and sometimes more distant relatives such as cousins or grandparents, suffer from recurrent pains and psychogenic problems, recurrent illness, and pseudo-illness. Parents in these families are excessively preoccupied with their children's health and it is unlikely that the children will grow up symptom-free.

These days many hospitals and institutes are running pain clinics particularly in western countries. These clinics offer a variety of treatment modalities including invasive measures such as medications, acupuncture, and surgery and non-invasive such as biofeedback, self-hypnosis and nutritional counselling. The 'greatest service that a doctor or nurse can provide to any patient is to listen and believe what the patient says about pain. However, when it is suspected that a patient does have a pain problem resulting from mental processes, extreme respect and diplomacy must be consciously employed during the assessment process Though the recent exciting discoveries regarding pain have made numerous major contributions to the relief of pain yet current information available on the neuroanatomy, physiology and psychology of nociception and its relation to pain perception is far from complete. Complicated diagnostically elusive pain problems still persist and this diagnostic dilemma often results in treatment dilemmas causing embarrassment to patient, doctor and the nurse.

Problems Related to the Use of Audio-Visual Aids in Science Teaching

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The use of sensory aids have a strong psychological and scientific base in the teaching-learning process as they give vividness to learning situation and also effect economy of time. Science is no doubt full of facts, concepts and principles, but its teaching is not just giving out information about them ot students. The ultimate purpose of science teaching is to educate pupils and make science a part of their life activity. This can be achieved by providing science education based on the needs, interests and abilities of the learners. For this, science teachers should plan and formulate an effective teaching programme based on the basic principles of good teaching.

The scientific approach regards teaching as a 'System' comprising of different sub-systems and believes that intelligent, creative and mechanical interaction among the sub-systems leads to effective teaching. The teacher and the learners are such sub-systems besides materials and aids; information and skills. The teacher is an important factor in the class room and has four different components at his/her disposal—

1. The language which functions as the medium.
2. The content material that is to be put across
3. The class room techniques which he employs.
4. The teaching materials which are his creative resources to co-ordinate these components in such a way that his work emerges as most productive.

The teaching materials consist of language materials and instructional aids. Instructional aids are those materials which a teacher uses to suppliment his teaching for making it more realistic and effective. These often provide the basis, the starting point and the points of reference of the student's and the teacher's teaching-learning activities in the class room.

It is beyond doubt that in science learning, the first-hand experience is the best type of educative experience and for such an experience, students should be allowed to see, hear, feel, smell and taste. But in many cases it may not be practical and desirable, and also at times, may prove expensive and dangerous. Hence, to give a clear and complete concepts of the scientific phenomena, vicarious or substituted experience should be provided to the students Such, substitutes for reality are often termed as Audio-Visual Aids.

Importance of Audio-Visual Aids in Science Teaching

The use of audio-visual aids is based on the assumption that clear understanding originates from sense experience. Besides providing vicarious experience, audio-visual aids are helpful in fixing up new learning, contribute to increased retentivity, cultivate scientific temper and also promote the development of higher faculties by stirring the imagination, thinking process and reasoning power of the students. They provide the stimuli for learning 'how', 'why', 'when' and 'where' They attract the interest and attention of the students and thus, act as best motivators and also as an antidote to the disease of verbal instruction. Thus, we can say that audio-visual aids are those sensory devices which are used for better communication of ideas to initiate learning, to clarify, establish and correlate concepts, interpretations and appreciations and which help in completing the triangular process of learning i e. motivation-clarification and stimulation by making the learning experience more concrete, more realistic and more dynamic. Thus, use of audio-visual aids in science teaching becomes inevitable.

Both, the Education Commission (1964-66) and the National Policy on Education (NPE 1986) and as modified in 1992 have highlighted the role of audio-visual aids in education and have laid great stress on their use to make teaching-learning more effective. The Education Commission even observed that it should indeed bring about an educational revolution in the country and stated that the supply of teaching aids to every school was essential for the improvement of quality of teaching.

It is quiet evident that the importance of use of audio-visual aids in the teaching-learning process has been recognised and widely accepted, yet it will be generally agreed that the impact of these activities on teaching practices in the vast majority of our schools has not been very significant. In the average school today, instruction still follows a mechanical routine and is heavily infected by the disease of verbalism and therefore remains as dull and uninspiring as before. This leads to the development of negative attitude among students towards science. Measures have been taken from time to time for adoption of technology in education but still a large gap is felt between the learning outcomes formulated and those achieved within the class room

To translate formulated task into reality, the basic need is to find out the reasons for less use of audio-visual aids in teaching as it is only when problem areas are identified, the government and the policy makers and all involved in the education process can take corrective measures in this regard.

It is with this objective in view that a study was carried out to find out the problems related to the use of audio-visual aids in teaching science subjects at the secondary level. The study was confined to Lucknow city.

Problems Related to the Use of Audio-Visual Aids

The analysis of the data, collected under the present study, showed that only 15.57 per cent teachers of Lucknow city use audio-visual aids in class room teaching whereas 84.42 per cent do not use them. This certainly is a dismal fact and points towards the extent the disease of verbalism has grasped our education system as also it indicates some loopholes within our system and to which the system itself is falling prey to. Though audio-visual aids were found to be available in 72.5 per cent schools but only 24 59 per cent teachers proclaimed it to be 'good', 32.78 per cent as 'fair' and a large number of teachers, 42.62 per cent stated the condition and availability of teaching aids as 'poor'. In majority of schools, there is total absence of projected aids and hence, teachers are compelled to stick to the conventional method of teaching in class room. They have only non-projected aids of the traditional type at their disposal and that too of inferior quality and not easily accessible. Thus, teachers regarded 'absence of sufficient equipment and material' that is user-friendly, easily accessible and according to requirement, as one of the major and primary cause of not using audio-visual aids in class room teaching besides other causes.

A favourable data which emerged during the study is that professional training of teachers has definitely a positive effect on their performance as only trained teachers were seen to use audio-visual aids. As education is a life long process, training of teachers should also be a continual process. In the light of this view, in-service training of teachers acquires a pivotal position. In-service training provides update information to teachers and therefore it should be an essential and integral part of teacher-training programme. But the study indicated that the in-service training of teachers acquires a backseat as 96.72 per cent teachers mentioned that never in their school any seminar or workshop is organized to acquaint them with upcoming desirable techniques to be adopted in the class room teaching process.

Another area of problem which the teachers mentioned is 'large class size' and 'lack of time'. Large class size and more number of working periods increase the workload of teachers and they are bound to be less incorporate audio-visual aids in their teaching. A teacher is inspired to use audio-visual aids more frequently with less number of students as then the class room is efficiently manageable.

More than 38 per cent teachers remarked the 'traditional type of work' as one of the prominent causes. Today, teaching is confined to transfer of information directly from the textbooks to the students in the class room by the teachers Lecture method is largely employed for this purpose. There has been an explosion in the field of science and technology and the new techniques have not found ways into the training course of teachers as well. The training course of teachers still sticks to the traditional syllabus The traditional approach being followed and, moreover, the training programme becoming more and more academic than practical tends one to link these factors to the present grim situation.

Teachers also remarked that curriculum is heavy and that departing away from the old method and adopting new techniques requires bold steps. According to them there is also lack of initiation and motivation within the school premises itself, which prevents them from going ahead with new techniques and therefore, they stick to the age-old methods. They complained that their principals do not ever take any interest in their teaching methodology and never motivate them to adopt new techniques

When teachers were enquired about the library facilities in their schools, 42.62 per cent teachers revealed that there is no such facility in their school. So, if in schools, library is non-functional, how can one expect students to read beyond their text books and also in absence of good related reference books for teachers, it cannot be expected from them to bring novelty in their teaching.

For this and other problems, the underlying major constraint is 'lack of finances.'35.24 per cent teachers revealed that they never prepare any aid due to lack of funds. Teachers who draw a reasonably handsome salary at times, use their own money for the continuation of the thought but this cannot be expected from teachers who are poorly paid.

Besides above mentioned factors, 81.96 per cent teachers regard our examination system as one of the causes of not facilitating teachers to use Audio-Visual Aids. The traditional system of examination encourages memorization of bookish knowledge and it does not permit first-hand experience of things and practical application of knowledge acquired. Also no credit for genuine hardwork and non-co-operation of parents often disheartens the teachers.

Concluding Remarks

Thus, these are some of the major problems related to the use of audio-visual aids in science teaching. Observations showed that use of audio-visual aids by teachers even though in low percentage is strongly backed by the consideration that science teaching is incomplete without its use. Hence, overhauling the education system according to the present need gains more importance. In this respect, the Education Commission (1964-66) recommended re-organisation of Teacher Education curriculum and suggested training of teachers in the use and preparation of simple and improvised teaching aids and use of school workshop and programme of work experience for it. The National Council of Teacher Education (NCTE) in 1978 provided a set of guidelines for adoption of task-oriented and performance-based curriculum. NPE (1986) also recommended the same. Time and again, emphasis has been laid on lifelong learning of teachers where pre-service and in-service education are inseparable. The role of District Institutes of Education and Training (DIETs), Colleges of Teachers Education (CETs) and Institutes of Advanced Study Education (IASEs) in providing in-service training to teachers needs more strengthening. The function of

Educational Technology cells and State Institutes of Educational Technology, previously established needs to be revaluated and updated.

At the same time. we should not look at one aspect i.e. overhauling teacher education only as the triangular linkage between educational policy, school curriculum and teacher education is inevitable because each of the three is related to the other two. Reforms are needed in all the three but the important tool for bringing about the change is the teacher we produce in our training institutions. We have to produce what is needed and in demand, to improve the quality of education. Proper planning on the part of the government and proper co-ordination at various levels is required to improve conditions. Last but not least, implementation procedure has to be accelerated to introduce dynamism and speed the reformative process without further delay.

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Finding Sum of Infinite Geometric Series by Experiment

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Most of us carry a notion that Mathematics is concerned only with abstract ideas and we cannot have practical activities and/or demonstrations for teaching and learning of concepts in mathematics. This perception also holds for dealing with the arithmetic progression (A.P.), geometric progression (G.P.) or harmonic progression (H.P.). As a result, a majority of teachers use only the chalk and talk method to explain the basic ideas concerning the series corresponding to these type of progressions and to solve the problems based on them. The only method employed to find the sum of different series is to apply the formulae in a mechanical manner

However, here an attempt has been made to demonstrate through a set of activities an activity method to arrive at the sum of an infinite geometric series. We begin with a specific example of a geometric series and then proceed in steps to generalize the results to deduce the formula for the series

An infinite geometrical series is written as

$a + ar + ar^2 + ar^3 + \ldots$

Sum of the above series $S = a/(1-r)$ if $|r| < 1$

Activity No. 1

Aim: To find the sum of the series

$$1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \frac{1}{256} + \ldots$$

Material required: Four sheets of paper. Besides the experimenter three more persons are to be involved in the activity.

Procedure: The activity aims at to distribute 4 sheets of paper equally amongst 3 persons

As we have 4 sheets of paper with us and we have to distribute them amongst 3 persons, to begin with we give one sheet of paper to each of the three persons involved in the activity. Now, we are left with ONE sheet of paper. It is difficult to divide this single sheet of paper equally into 3 parts. So, we cut the sheet into 4 equal parts bisecting it twice and then give one piece to each.

This time each one has receive $\frac{1}{4}$th of the initial sheet of paper and the experimenter is left with $\frac{1}{4}$th of the sheet. So, each person has received $1+\frac{1}{4}$ Repeating the above process again each one will get $\frac{1}{16}$th of the sheet of paper received by each at the beginning (Fig. 1).

Observations

Repeating in this manner each person will receive the pieces of paper in the following manner·

$$1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \frac{1}{256} + \,..$$

Calculations: Now the question is how much of a sheet of paper one got?

Total Number of sheets of paper distributed = 4

Number of persons who received them = 3

Result

Obviously 4 sheets of paper were equally distributed amongst 3 persons and hence each must have $\frac{4}{3}$ sheets of paper.

Inference: As per the formula for the sum of the series, $S = \frac{4}{3}$ which is the same as obtained through the activity. (Here $a = 1$ and $r = \frac{1}{4}$)

Activity No. 2

Aim: To find the sum of series—

$$1 + \frac{1}{2} + \frac{1}{4} + \ldots$$

Material required: Two sheets of paper. Besides the experimenter one more person is to be involved.

Procedure: The person involved in the activity is given half of the sheets of paper the experimenter possesses at any instant of time and every time the remaining sheet or the part of the sheet is further divided in two equal parts.

So, first we will give one sheet of paper and are left with one sheet. Now, the second sheet of paper is cut into two parts and one part is given to the person, so he gets $\frac{1}{2}$ the sheets of paper In all the number of sheets of paper received are $1 + \frac{1}{2}$. These steps are repeated over and over again so that after every

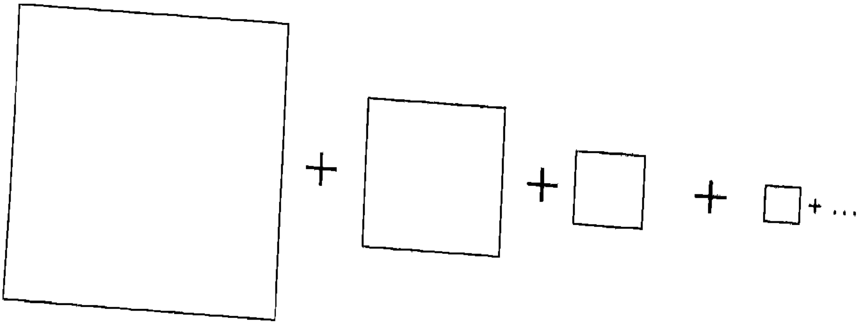

Fig. 1

step $\frac{1}{2}$ of the sheet left at the end of previous step is handed over to the person.

Observations

In this manner total number of sheets the receiver gets, $1+\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+.$

Calculations: Now the question is how much of a sheet of paper one got?

Total Number of sheets distributed = 2

Number of persons who received them = ONE

Result

Obviously 2 sheets of paper distributed to only one person and hence he must have $\frac{2}{1}$ = 2 sheets of paper.

Inference: As per the formula, for the sum of the series S = 2, which is the same as obtained through the activity.

(Here a = 1 and r = $\frac{1}{2}$)

Activity No. 3

If in the above experiment one begins with one sheet of paper, the series will be as:

$$\frac{1}{2} = \frac{1}{4} + \frac{1}{8} + \ .$$

One can generalize the outcome of the above activity by assuming that a single sheet of paper can be cut into any number of equal parts. Suppose the sheet of paper is cut into n equal parts to distribute it among (n – 1) persons [even if it may be possible to cut the sheet of paper into (n–1) equal parts, the paper has to be cut into n parts, to have the G.P. series].

Generalization of the Result

Aim: To find the sum of series:

$$1+\frac{1}{n} + \frac{1}{n^2}+\frac{1}{n^3}+\frac{1}{n^4}\cdot\cdot$$

Material required: n sheets of paper. Besides the experimenter (n –1) more persons are to be involved in the activity.

Procedure: Distribute n sheets of paper amongst (n–1) persons in the following manner. To begin with give one sheet of paper to each of the (n–1) persons. Now, cut the remaining one sheet of paper into n equal parts and give one part to each of the (n–1) person. Now each one has got $1+\frac{1}{n}$. Next, cut the remaining $\frac{1}{n}$th part of the sheet of paper again into n equal parts and again give one piece each and go on repeating this.

Observations

Thus, the total number of sheets received by each person will be

$$\frac{1}{n} + \frac{1}{n^2} + \frac{1}{n^3} + \frac{1}{n^4} \ ..$$

Calculations: Now the question is how many sheets of paper each person received ?

Total Number of sheets distributed = n

Number of persons who received them = (n – 1)

Result

Obviously n sheets of paper were equally distributed amongst (n–1) persons and hence each one must have $\frac{n}{(n-1)}$ sheets of paper.

Inference: As per the formula, for the sum of the series $S = \frac{n}{(n-1)}$ (Here $a = 1$ and $r = \frac{1}{n}$) which is the same as obtained through the activity.

In the above illustrative cases we have taken n as a positive integer, now to have n as a negative integer i.e. $a = 1$, and $r = \left(-\frac{1}{2}\right)$ we can perform the activity in the following manner

Activity No.4

Aim: To show the sum of the series:

$$1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \,..$$

Material required: One sheet of paper. Besides the experimenter one more person is to be involved in the activity.

Procedure: To begin with, the experimenter hands over a sheet of paper to the person involved in the activity. The person after receiving the sheet of paper cuts it into two equal parts and returns one part to the experimenter. The experimenter again divides the piece of paper in two equal parts and hands over one part to the other person who in turn divides in into two equal parts and returns back one part to the experimenter. This process is repeated over and over again.

Observations

Thus, the person receives:

$$1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \,..$$

of the sheet of paper while the experimenter receives:

$$\frac{1}{2} \pm \frac{1}{4} + \frac{1}{8} \pm \frac{1}{16} \pm \frac{1}{32} \pm \,..$$

Calculations: Now if we compare the portion of the sheet of paper received by the other person at every stage we find that it is two times of that received by the experimenter. Thus, the person has received $\frac{2^{rd}}{3}$ of the sheet of paper and the experimenter has the remaining $\frac{1^{rd}}{3}$ part of the paper (Note that at the end of even number of steps in the process of distribution, the ratio of the portion of the sheet of paper received by them is in the ratio of 2:1 and hence the person is having $\frac{2^{rd}}{3}$ and the experimenter is having $\frac{1^{rd}}{3}$ which explains the above conclusion).

Result

Thus, the sum of the series :

$$1 \pm \frac{1}{2} + \frac{1}{4} \pm \frac{1}{8} + \frac{1}{16} \pm \frac{1}{32} + \ldots = \frac{2}{3}$$

and the sum of the series:

$$\frac{1}{2} \pm \frac{1}{4} + \frac{1}{8} \pm \frac{1}{16} + \frac{1}{32} \pm \ldots = \frac{1}{3}$$

Inference: As per the formulae for the sum of the series, we find that for the 1st series the sum is S_1 $\frac{2}{3}$ (Here $a = 1$ and $r = -\frac{1}{2}$) and sum of the 2nd series $S_2 = \frac{1}{3}$ (Here $a = \frac{1}{2}$ and $r = -\frac{1}{2}$).

Activity No. 5

Aim: To find the sum of series ·

$$1 \pm \frac{1}{4} + \frac{1}{16} \pm \frac{1}{64} + \frac{1}{256} \pm$$

Material required: One sheet of paper. Besides the experimenter two more persons are to be involved in the activity.

Procedure: In this activity, the first person is given a sheet of paper which he cuts, into four equal parts. He retains three parts and returns one part i.e. $\frac{1}{4}$th of the sheet of the paper to the other. The second person also cuts the given piece of paper into four parts, retains its three parts and gives one part back to the first. The process continues in this manner.

Observations

Thus, the first person has received piece of paper as follows:

$$1 - \frac{1}{4} + \frac{1}{16} - \frac{1}{64} + \frac{1}{256} - \,..$$

while the second person has received :

$$\frac{1}{4} - \frac{1}{16} + \frac{1}{64} - \frac{1}{256} + \ldots$$

Calculations: Here, initially the first person is having $\frac{3}{4}$ of the sheet of paper while the second person is having $\frac{3}{16}$ of the paper i e. the ratio of the paper received by them is in the ratio 16:4 = 4·1 and hence at the end, the first person is having $\frac{4}{5}$th and the second person is having $\frac{1}{5}$th of the sheet of paper.

Result

The first person has received the piece of paper as the sum of the series:

$$1 - \frac{1}{4} + \frac{1}{16} - \frac{1}{64} + \frac{1}{256} - \ldots = \frac{4}{5}$$

and the second person has received the piece of paper as the series:

$$\frac{1}{4} - \frac{1}{16} + \frac{1}{64} - \frac{1}{256} + .. = \frac{1}{5}$$

Inference: As per the formula, for the sum of the series, we find that for 1st series the sum is $S_1 = \frac{4}{5}$ (Here $a = 1$ and $r = -\frac{1}{4}$) and sum of the 2nd series is $S_2 = \frac{1}{5}$ (Here $a = \frac{1}{4}$ and $r = -\frac{1}{4}$).

Generalization of the Result

Aim: To find the sum of series:

$$1 - \frac{1}{n} + \frac{1}{n^2} - \frac{1}{n^3} + \frac{1}{n^4} - \ldots,$$

where n is to be any integer.

Material required: One sheet of paper Besides experimenter, two more persons are to be involved in the activity

Procedure: In this activity the first person receives one sheet of paper and then he cuts it into n equal parts. Retaining (n−1) parts of the sheet of paper, the first person gives away one part i e. $\frac{1}{n}$th of the paper to the other.

The second person also cuts the part of the paper received into n equal parts. After retaining (n−1) parts of these with him, he gives away one part to the first and the process continues in this manner.

Observations

Thus, the first person has received the pieces of paper as follows:

$$1-\frac{1}{n}+\frac{1}{n^2}-\frac{1}{n^3}+\frac{1}{n^4}-\ldots$$

Second person has received

$$\frac{1}{n}-\frac{1}{n^2}+\frac{1}{n^3}-\frac{1}{n^4}\ldots$$

Calculations: First person is having $\frac{(n-1)}{n}$ sheet of the paper as compared to the second person who has $\frac{(n-1)}{n^2}$ portion of the sheet of the paper. In other words, the ratio of the sheets of paper received them is n^2. n or n:1 and hence the first person is having $\frac{n}{n+1}$ and second person is having $\frac{1}{(n+1)}$ of the sheet of paper.

Result

The first person has received the piece of paper as the sum of the series:

$$1-\frac{1}{n}+\frac{1}{n^2}-\frac{1}{n^3}+\frac{1}{n^4}-\ldots=\frac{n}{(n+1)}$$

second person has received the piece of paper as the sum of the series:

$$\frac{1}{n}-\frac{1}{n^2}+\frac{1}{n^3}-\frac{1}{n^4}+\ldots=\frac{1}{(n+1)}$$

Inference: As per the formula for the sum of the series; for the 1st series we get

$$S_1=\frac{n}{(n+1)}\ \left(\text{Here } a=1 \text{ and } r=-\frac{1}{n}\right)$$

and for the 2nd series, we get

$$S_2=\frac{1}{(n+1)}\ \left(\text{Here } a=1 \text{ and } r=-\frac{1}{n}\right)$$

It is hoped that these activities would be helpful to the teachers to introduce the concepts relating to geometric series to the children through a play-way (Activity) method It is envisaged that adoption of this method in classroom will certainly create an interest for learning the concepts among the students and in the process also help to drive away uncalled for fear towards learning of mathematics As these topics are included at the secondary/senior secondary stages, it is expected that this activity based approach may be fruitful for the teaching and learning community.

The Fascinating Journey of Chromatography

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Chromatography has numerous applications in biological and chemical fields. It is widely used in biochemical research for the separation and identification of chemical compounds of biological origin. Chromatography is employed to analyse complex mixtures of hydrocarbons. As a separation method, chromatography has a number of advantages over other techniques such as crystallization, solvent extraction and distillation It is capable of separating all the components of a multicomponent chemical mixture without requiring an extensive foreknowledge of the identity, number or relative amounts of the substances present. It is versatile in that it can deal with molecular species ranging in size from viruses composed of millions of atoms to the smallest of all molecules — hydrogen — which contains only two atoms. Furthermore, it can be used even with large or small amounts of material. Some forms of chromatography can detect substances present at the picogram (10^{-12} gram) level, making this method a superb trace analytical technique extensively. It is used in the detection of chlorinated pesticides in biological materials and the environment, in forensic science, and in the detection of both therapeutic and abused drugs. Its resolving power is unequalled among separation methods.

Chromatography is defined as a technique for separating the components or solutes of a mixture on the basis of the relative amounts of each solute distributed between a moving fluid stream, called the mobile phase, and a contiguous stationary phase. The mobile phase may be either a liquid or a gas, while the stationary phase may be either a solid or a liquid The kinetic molecular motion continuously exchanges solute molecules between the two phases. If, for a particular solute, the distribution favours the moving fluid, the molecules will spend most of their time migrating with the stream and will be transported away from other species whose molecules are retained longer by the stationary phase. For a given species, the ratio of the time spent in the moving and stationary regions is equal to the ratio of its concentrations in these regions, known as the partition coefficient. A mixture of solutes is introduced into the system in a confined region or narrow zone (the origin), whereupon the different species are transported at different rates in the direction of fluid flow. The driving force for solute migration is the moving fluid, and the resistive force is the solute affinity for the stationary phase. The combination of these forces, on manipulation by the analyst,

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produces the separation of various components.

The first purely pragmatic application of chromatography was with dyes. Various dye mixtures were tested by dipping strings or pieces of cloth or filter paper into a dye vat. The dye solution migrated up the inserted material by capillary action, and the dye components produced bands of different colours In the 19th century. several German chemists carried out several experiments to explore the application of chromatography They observed, for example, the development of concentric, coloured rings by dropping solutions of inorganic compounds onto the centre of a piece of filter paper. A treatise was published in 1861 describing the method and giving it the name "capillary analysis."

The discovery of chromatography is generally attributed to the Russian botanist Mikhail S. Tsvet, because he recognized the physicochemical basis of separation and applied it in a rational and organized way to the separation of plant pigments, particularly the carotenoids and the chlorophylls. Tsvet's book, published in 1910, described a technique that is used today in essentially the same form. He packed a vertical glass column with an adsorptive material, such as alumina, silica, or powdered sugar, added a solution of the plant pigments to the top of the column, and washed the pigments through the column with an organic solvent.

The pigments separated into a series of discrete coloured bands on the column, divided by regions entirely free of pigments. Because Tsvet worked with coloured substances, he called the method chromatography (from Greek words meaning colour writing). Tsvet's development of chromatographic procedures was generally unknown to chemists in the Western world because he published either in German botanical journals or in Russian works. In 1931, chromatography emerged from its relative obscurity when the German chemist Richard Kuhn and his student, the French chemist Edgar Lederer, reported the use of this method in the resolution of a number of biologically important materials In 1941 two British chemists, Archer J P. Martin and Richard L.M. Synge, began a study of the amino acid composition of wool.

Their initial efforts, in which they used a technique called liquid-liquid countercurrent distribution, failed to give them adequate separation. Therefore, they conceived of an alternative method in which one liquid was firmly bound to a finely granulated solid packed in a glass tube and a second liquid, immiscible with the first, was percolated through it Silica gel served as the granular solid. Martin and Synge pictured silica gel as composed of water tightly bonded to the crystals of silica. The mobile phase was chloroform. Their work with this technique was remarkably successful. Although their method was mechanically identical with Tsvet's approach, it was innovative as it involved the concept of a stationary liquid (water) supported on an inert solid (silica), with the result that the solute molecules partitioned between the stationary liquid and a separate mobile liquid phase (chloroform).

The technique used by Martin and Synge came to be called partition chromatography. At that time, they suggested that the moving phase could well be a gas It is a historical oddity that this idea was overlooked for nearly a decade, possible because of the war, until Martin in collaboration with the British chemist Anthony T James initiated studies of gas-liquid partition chromatography. In 1952, Martin and Synge were awarded the Nobel Prize for their work, perhaps not so much for the newness of the technique but for a model that suggested other systems, a mathematical theory, and an applicability to amino acid and peptide separations with far-reaching impact on biochemical studies.

The initial partition-chromatography system presented difficulties because of lack of reproducibility in the properties of the silica gel and lack of uniformity in the packing of columns. Partly for this reason, Martin and his co-workers worked out a new procedure in which the stationary medium was a sheet of filter paper. The paper was thought of as water bonded to cellulose, providing another partition method. The technique gave the desired reproducibility, and from the beginning of 1940s, paper chromatography found wide application in the analysis of biologically important compounds, such as amino acids, steroids, carbohydrates and bile pigments. In this field, to a large extent it replaced the column technique initiated by Tsvet.

Motivated probably by the same drawbacks to column chromatography, two Soviet pharmacists, Nikolay A Izmaylov and Maria S. Shrayber, distributed the support material as a thin film on a glass plate. The plate and support material could then be manipulated in a fashion similar to that of paper chromatography The results of the Soviet studies were reported in 1938, but the potential of the method was not widely realized until 1956, when the German chemist Egon Stahl began intensive research on its application. This system became known as thinlayer chromatography (TLC).

Yet another chromatographic technique, gas chromatography, was first carried out in Austria in 1944 by the chemist Erika Cremer, who used a solid stationary phase. The first extensive exploitation of the method was made by Martin and James in 1952, when they reported the elution gas chromatography of organic acids and amines. In this work, small particles of support material were coated with a nonvolatile liquid and packed into a heated glass tube. Mixtures injected into the inlet of the tube and driven through by compressed gas appeared in well-separated zones. This development was immediately recognized by petroleum chemists as a simple and rapid method of analysis of the complex hydrocarbon mixtures encountered in petroleum products. British Petroleum Co. and Shell Oil Co. immediately began basic research in their own laboratories Various instrument manufacturing companies envisaging an extensive market, also made major contributions.

In 1957, while doing a theoretical study of gas chromatographic columns, Marcel J.E. Golay, as a consultant for the Perkin-Elmer Corporation, concluded that a very long column (90 to 180 metres or 300 to 600 feet) of narrow-diameter tubing (internal diameter of 0.25 millimetres with its wall coated with a thin film of liquid would yield superior separations. Fortunately, at about the same time, detectors with extremely low limits of detection, which could sense the small sample sizes required by these new columns became available. These capillaries, or Golay columns, now called open-tubular columns and characterized by their open design and an internal diameter of less than one millimetre, had an explosive impact on chromatographic methodology. It is now possible to separate hundreds of components of a mixture in a single chromatographic experiment.

Molecular sieves are porous substances that trap a mobile-phase gas Large molecules cannot enter the pores. Therefore they flow unimpeded through the system. Small molecules are interrupted in their migration as they meander in and out of the pores by diffusion. Molecules of intermediate sizes show different rates of migration, depending on their size. In 1959 Per Flodin and Jerker Porath in Sweden developed cellulose polymeric materials that acted as molecular sieves for substances dispersed in liquids. This extended the molecular weight range of chromatography to polypeptides, proteins, and high-molecular weight polymers. The generic term for such separations is size-exclusion chromatography (SEC).

In 1964, an American chemist, J Calvin Giddings, referring to a theory largely worked out for gas chromatography, summarized the necessary conditions that would give liquid chromatography the resolving power achievable in gas chromatography, that is, very small particles with a thin film of stationary phase in small-diameter columns. The development of the technique now termed high-performance liquid chromatography (HPLC) depended on (i) the development of pupms that would deliver a steady stream of liquid at high pressure to the column to force the liquid through the narrow interstitial channels of the packed columns at reasonable rates and (ii) detectors that would sense the small sample sizes mandated. At first, only adsorptive solids were used as the stationary phase, because liquid coatings were swept away by the mobile phase.

Previously gas chromatography had employed chemical bonding of an organic stationary phase to solids to reduce adsorptive activity; Istvan Halasz of Germany exploited these reactions to cause a separation based on liquid solution effects in the bonded molecular layers. These and similar reactions were employed to give firmly attached molecules that acted as a thin film of solvent in liquid systems. These bonded phases gave high-performance liquid chromatography such scope and versatility that the technique is now a dominant method for separations.

Ion exchangers are natural substances. For example, certain clays or deliberately synthesized resings, containing positive ions (cation exchangers) or negative ions (anion exchangers), that exchange with those ions in solution have a greater affinity for the exchanger. This selective affinity of the solid is called ion, or cation exchange chromatography (IEC) The first such chromatographic separations were reported in 1938 by T.I Taylor and Harold C. Urey, who used a zeolite.,The method received much attention in 1942 during the Manhattan Project as a means of separating the rare earths and transuranium elements, fission products of uranium and other elements produced by thermonuclear explosions. Ion-exchange chromatography can be applied to organic ion separations and is of special importance for the separation of amino and nucleirc acids

The solubility of solids in gases at high pressure had been observed as early as 1879 In 1958, the British scientist James Lovelock suggested that gases above their critical temperature (i e., the temperature above which a liquid phase cannot be produced by increasing the pressure) might be used at high pressure as mobile phases A substance in this state is termed a supercritical-fluid. At very high pressure, the density of the fluid can be 90 percent or more of the liquid density. The German chemist Ernst Klesper and his colleagues, working at the Johns Hopkins University, were the first to report separation of the porphyrins with dense gases in 1962. Carbon dioxide at 400 atmospheres (One atmosphere equals 760 millimetres, or 29.92 inches, of mercury, standard sea-level pressure is one atmosphere) is a typical supercritical-fluid mobile phase. In an extreme case, Giddings and his group used gases at pressures of up to 2,000 atmospheres to chromatograph carotenoids, sugars, nucleosides, amino acids, and polymers Supercritical-fluid chromatography bridges a gap between gas chromatography and liquid chromatography. In gas chromatography, concentration of solutes in the gas phase is achieved with increased temperature. Supercritical-fluid chromatography achieves this result with increased pressure so that thermally unstable compounds may be analysed. Additional advantages include increased speed and resolution.

A technique exhibiting great selectivity, affinity chromatography, was first described by Pedro Cuatrecasas and his coworkers in 1968. In these separations, a biomolecule such as an enzyme binds to a substrate attached to the solid phase while other components are eluted. The retained molecule can subsequently be eluted by changing the chemical conditions of the separation.

Another separation technique is based on the fact that the velocity of a fluid through a tube is not uniform. In the region immediately adjacent to the wall the fluid is nearly stationary. At distances farther from the wall, e velocity increases, reaching a maximum value at the centre of the channel. In 1966, Giddings conceived the idea that a field, electrical or gravitational, might be used to selectively attract particles to the wall, where they will move slowly through the system. Diffusion, away from the high concentrations at the wall, into faster inner streams would enhance migration. The net effect would yield differential migration. A thermal gradient between two walls has also been used. This recently developed technique is called field-flow fractionation. It has been termed one-phase chromatogaphy because there is no stationary phase. Its main applications are to polymers and particulate matter. One phase chromatography has been used to separate biological cells, sub cellular particles, viruses, liposomes, protein aggregates, fly ash, colloids and pigments.

Uniform Usage of Scientific Literature Common to Different Disciplines of Science

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In recent years, due to enormous prospects in inter-disciplinary areas, there has been a move for cross-boundary thinking and the application of concepts in one discipline to the solving of problems in another discipline. Success of this move is facilitated only if uniform units, terms, data and representation of concepts are incorporated in learning materials such as textbooks, and laboratory manuals However, survey of the literatures of different disciplines of science i.e. Chemistry, Physics and Biology at Secondary and Senior Secondary levels, reveals that there are some variations in the use of units, terms, data and representations of concepts in different disciplines. Here, on the basis of a survey, some of these areas have been identified and accordingly recommendations have been made. The work is not exhaustive. Some more areas can be traced and necessary uniform changes can be effected in the literature of different disciplines

Units: Although there is a complete shift from imperial system to metric system in the literatures of different disciplines, yet it has been observed that even in metric system CGS and MKS both schemes are followed Now, there is universal acceptance for following SI (Systeme Internationale) units only. Seven SI base units are given in Table 1. Decimal fractions or multiples of SI units are expressed by putting certain prefixes before the names of the units The various prefixes are given in Table 2. Application of these prefixes can be illustrated by taking a few examples. A hundredth of a metre corresponding to 10^{-2} is centimetre for which symbol cm is used. For 10^{3} metre we use the term kilometre and symbol as km.

The unit of bond length in chemistry literature now is written in SI units i.e. picometer (pm) However, in biology literature different bond lengths are given is Angstrom (A°) Unit, for example C-C bond length 1.5A°. This should be written as 154 pm. Also, in biology and at times in chemistry literature, unit of wavelength is given in A° and somewhere in m μ. But now this unit has been discarded and nm (nanometer) SI unit is followed.

There are some SI derived units also. These units are obtained by combination of base units. For example, physical quantity, volume is expressed as m^3. For many years in all disciplines of science, the fundamental unit employed for measuring volume of liquids was 'litre'. However, for scientific purposes the convenient unit is cubic decimetre (dm^3). But now 'litre' has been accepted as a special name for cubic decimetre by discarding the original definition of the litre. Original definition of litre was "the volume which is occupied by one kg of water at 4°C". Due to this definition, relationship between litre and cubic decimeter holds as 1 litre = 1.000028 cubic decimetre. Nonetheless, it is recommended that only cubic decimetre unit should be used to express the results of high precision.

Physical Constants: It has been found that in the literature of different disciplines different values for physical constants (for same units) and different units for the same physical constant have been followed. It is suggested that the same SI units and same certified values should be used.

Symbols: It has been found that all science disciplines have not adopted new changes recommended by different international organisations for symbols and names of elements. The symbols of elements with atomic number 104, 105, 106, 107, 108 and 109 are; Rf (Rutherfordium), Db (Dubnium), Sg (Seaborgium), Bh (Bohrium), Hs (Hassium), Mt (Meitnenum) respectively (accepted by IUPAC Bureau, 1994). It is to be added here that no differences have been found regarding the symbols and names of elements having atomic numbers from 1 to 103. The charge on a cation e.g., cation of calcium should be represented as Ca^{2+} (formerly Ca^{++}) and charge on an anion e.g.,anion of borate should be represented as BO_3^{3-} (formerly BO_3). Gramm and litre are now assigned the symbols g (formerly gm) and L (formerly l) respectively.

Terms: Some scientific terms in different disciplines bear different names. These should be uniform and as per recommendations of International Organisations. For example, optical density should be replaced by absorbance and molar extinction coefficient as molar absorptivity. It has been found in biology literature that discarded terms; optical density and molar extinction coefficient are in vogue. The term volumetric analysis was formerly used but it has now been replaced by titrimetric analysis since it is considered that the latter expresses the process of titration rather better while former may be confused with the measurement of volume, such as those involving gases. The same changes should be brought about in the literature of different disciplines. The terms, atomic weights and molecular weights have been changed to atomic masses and molecular masses respectively.

Representations of Concepts: Process of Photosynthesis is dealt with, both in chemistry as well as in biology. However, reaction representing the photosynthesis has been differently given in different disciplines It is correctly represented as:

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

However, just to satisfy the requirement of balancing the equation, in some books, the equation has been written as :

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Such representations create misconceptions amongst students. A perusal of some books of biology indicates that "preparation of solution of copper sulphate", is presented as "preparation of solution of $CuSO_4$ (to express in formula form). While, in formula form it should be $CuSO_4$. $5H_2O$. (However, it may be mentioned that nowhere preparation of solution of anhydrous copper sulphate, $CuSO_4$, is required). This is misrepresentation of the chemistry concept.

Synthetic and Analytical Data: It has been found that the processes of synthesis and analysis bear different expressions of concentrations of solutions of reagents. It has been found that in some biology and physics textbooks, solutions have been given in ppm or in μg/1 while in chemistry these are expressed in molarity or normality It has been recommended by international body that concentrations of solutions should be expressed in molarity and the same should be followed in literature of all disciplines which will facilitate direct use of data from one discipline to another

TABLE 1

Base SI Units

Quantity	*Unit*	*Symbol*
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s (Sec)
Electric Current	Ampere	A
Temperature	Kelving	K
Luminous intensity	Candela	cd
Amount of substance	Mole	mol

TABLE 2

Prefixes for Expressing Decimal Multiples of Units

Prefix	*Symbol*	*Multiple*
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	K	10^{3}
hecto	h	10^{2}
deka	da	10
deci	d	10^{-1}
centi	c	10^{-12}
milli	m	10^{-3}
micro	M	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Teacher Involvement to Evaluate Science Achievement

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Much is written about using standardized and state mandated tests to measure student growth in science Little, however, is written about using teacher developed tests to measure student science achievement in the classroom Too frequently, standardized tests and state mandated tests omit learner progress in the every day learnings in science achievement in the classroom. Teacher developed tests can be more valid and reliable than either standardized or state mandated tests. Standardized tests are global and do not have accompanying objectives for the teacher to use in teaching science. State mandated tests may have accompanying objectives which teachers may use to gauge their teaching. The teacher may then teach in a manner whereby the state mandated test might have rather high validity since what is taught may be tested when using the state mandated test. Selected states omit science content and skills in the mandated tests. The feeling then might well be that science is not as important as reading and mathematics, for example.

There is probably no better way to write valid test items than the classroom teacher doing the writing who knows and understands what has been taught in the classroom. The science teacher also has understandings of what the developmental level of the student is when writing appropriate test items. Thus, test items need to be written on the reading and understanding level of the students who are to take the test.

Not many teachers, however, are acquainted with standards to use in test writing

Standards for Test Writing

The National Research Council (NRC) has just released publication of *Classroom Assessment and the National Education Standards* (National Science Teachers Association, 2001). Six goals are listed in the introduction of this publication. These are—

- Articulate a research based rationale for helping teachers improve classroom assessment.
- Clarify the concept of effective classroom assessment.
- Provide illustrations and guides to the development and selection of assessment processes and tools.
- Assist teacher educators and staff developers who will include assessment in their work with prospective and practicing teachers.

- Address issues that school and district decision makers face in their efforts to improve classroom assessment.

What students learn each day in ongoing science lessons and units of study is important. A single percentile given to show student results on a standardized or state mandated test for an entire school year, or other selected interval of time, does not provide a comprehensive picture of the learner's achievement in science (Ediger, 1990, 241-246). To use either of these tests to reveal learner progress in science has the following weaknesses —

1. multiple choice test items are generally used for student responses to indicate what has been learned. These are paper/pencil test items to measure facts, concepts, and generalizations acquired by students Major emphasis may be placed here upon measuring factual information achieved by students since this is the easiest kind of content to measure in a multiple choice test.
2. hands on approaches in science teaching and learning might well be greatly minimized or ignored since their strengths and weaknesses cannot be machine scored. A science teacher who has stressed a hands on approach in student learning in the classroom may find the multiple choice test items tend to measure verbal intelligences such as reading largely or only.
3 no exceptions may be made for individual differences among students Thus all students have the same amount of allotted time to complete the standardized or state mandated test, all experience the same directions for test taking, all responses are assessed using the same answer key, and all respond to the same kind of test items. Selected students need more test taking time than do others as well as to have directions explained more thoroughly for taking the test. Then too, there may be more than one correct answer than what is presented in the assessment key. Reading multiple choice test items may not be a favourite way of revealing what has been learned in science. A handicapped student, especially, may need special accommodations.
4. science as a curriculum area may not appear on a state mandated test since major emphasis is being placed upon measuring reading and mathematics achievement. Standardized tests, if they do contain test items pertaining to science, may have too few test items pertaining to this vital area of academic achievement.
5. validity may well be lacking if the test stresses abstract learnings such as students reading and responding to multiple choice test items and the classroom teacher having emphasized concrete and semi-concrete approaches in teaching science.

A sampling of every day science achievement of students may be incorporated into a science portfolio. The portfolio, as an example, may contain the following entries:

1. snapshots of hands on approaches from ongoing lessons and units of study.
2 written work pertaining to summaries; outlines; book reports; as well as expository, creative, and narrative writings.
3 a video tape of collaborative endeavours of students to notice the quality of interactions.
4. tape recordings of oral presentations such as a book report.
5. drawings of construction items made for science experiments and demonstrations.
6 dramatizations, evaluated on a five point scale, pertaining to a unit on famous scientists, for example.
7 self evaluation of students in terms of quality criteria.
8. art products such as murals, diagrams, and other illustrations developed of what was studied in science units of study.
9. test results of classroom developed tests measuring achievement in ongoing units and lessons.
10. student/teacher planning of what is left to learn within a specific unit in science A carefully designed rubric may be used to assess the quality of each portfolio (Ediger, 2001, 150-155).

Multiple Intelligences Theory

Multiple Intelligences Theory (Gardner, 1993) indicates that there are numerous possibilities for students to reveal in achievement. Here, students may use their own individual strengths to indicate achievement through the following ways:

1. verbal intelligences such as in reading and responding to test items.
2. logical intelligence as in reasoning to secure information.
3. musical/rhythmical such as in writing lyrics and putting the words to music to reveal what has been learned.
4. intrapersonal intelligences whereby the strengths lie within the individual working by the self to indicate achievement from a lesson or unit of study.
5. interpersonal intelligences in which a learner best reveals learnings obtained through collaborative endeavours
6. bodily/kinesthetic whereby the student indicates what has been learned through manual dexterity. There are a plethora of ways here for students to show achievement in science units such as in constructing models and objects, making science equipment, and doing projects.
7 scientific intelligences which is truly the heart of the science curriculum as in objective thinking about nature and the natural world.

The student with teacher guidance may select the approach(s) to be used to reveal what has been learned in science lessons and units of study. This puts more responsibility upon the student, rather than upon test writers far removed from the local classroom, in deciding how to be assessed to indicate achievement. Each of the above named intelligences possessed by a student may be used to show progress in the science curriculum.

To use multiple intelligences theory requires in-service education for teachers. Classroom teachers need to study, see models of multiple intelligences theory in operation to assess learner achievement, and eventually implement with mentor assistance diverse facets of this philosophy of evaluation. In-service education is necessary then for teachers to be able to use new procedures in the assessment process.

Learning Styles Theory in the Assessment Process

Under which classroom environmental conditions do students achieve more optimally? Learning styles theory has much to offer in thinking about the learning environment for students in the classroom. Searson and Dunn (2001) in their research have identified factors which assist or hinder individuals in the classroom in achieving as optimally as possible:

1. acceptable noise levels, temperature readings, as well as formal versus informal seating arrangements.
2. emotional elements such as conformity versus nonconformity, as well as preferences for choices as to what to learn.
3. sociological factors such as studying alone or with others as well as preferring collegial relations versus structure with a more authoritative teacher.
4. physiological factors such using auditory, tactual, and/or kinesthetic ways of learning. Included too are moving around or sitting still as well as eating versus not eating while concentrating on the task at hand.
5. psychological factors such as being an analytic learner who focuses on a step by step fashion which leads to an understanding, as compared to global learners who desire to understand what is learned and how it relates to themselves before focusing on facts. Analytic students respond best to printed words whereas global learners respond better to illustrations and pictures.

Workshops and faculty meetings are needed for teachers to become thoroughly familiar with learning styles theory of teaching and learning as well as using its components in the assessment procedure. Teachers need to consider learning styles theory when evaluating under which conditions students do best in achieving objectives in science instruction.

Written Tests in the Science Curriculum

There are selected criteria which need to be used by teachers in writing valid and reliable test items to measure learner achievement and progress. Quality test items then need to be in the offing for assessment results to be useful for the science teacher. Poorly written, vague items will not provide the useful information needed to design the science curriculum Which are the selected criteria for the teacher to use?

Multiple choice test items are used very frequently by writers of standardized and criterion referenced tests. Teacher written multiple choice test items should possess the following.

1 they should contain a stem and four plausible responses Four is not a magic number, but if there are three responses, then the student has a better chance of guessing the correct answer. If five responses are in the offing, it might be quite complex in writing each as being plausible or rational.

The following is a model multiple choice item:

Which is *incorrect* in naming the three states of matter?

(a) solids

(b) rocks

(c) gases

(d) liquids.

There is only one correct answer in that rocks are not one of the three states of matter The test item is quite factual. However, there are vital facts for students to understand and use in developing increasingly a more complex science vocabulary. Thus, there are a plethora of liquids, solids, and gases for students to encounter in a quality, sequential curriculum. Then, too, relevant facts are the building blocks for higher levels of cognition.

2. no clues are to be given when the student encounters sequential multiple choice test items Thus, test item number one should not provide a clue as to which is the correct response for test item number two, and others sequentially.

3. each stem needs to be grammatically correct with the four plausible responses —

   Three major classification of rocks are

   (a) sandstone, basalt, and marble.
   (b) igneous, metamorphic,and sedimentary.
   (c) liquids, solids, and gases
   (d) conglomerate, magma, and shale.

4. the test items need to be arranged in ascending order of complexity. The reason for this being psychological in that the easier test items may build self confidence within students to tackle the increasingly more complex test items sequentially.

5 written test items must cover what has been taught in the classroom so that increased validity is in evidence.

6 peer review of test items may be advisable to take out the weaknesses in a multiple choice test.

7. balance among different topics covered in science instruction need to appear on the test. If environmental education has been taught in class for example, then related test items need to appear on the test. Face validity is then in evidence (Ediger, 1994, 1-4)

8. feedback from student test results should be used to pinpoint weaknesses and thus reteach that which is needed.
9. printouts of learner test results provide a basis for assessment of the quality of test items. If too many miss an item, perhaps it needs to be revised to make it more meaningful.
10. tests are an integral part of instruction and should be used to improve the curriculum, not to make comparisons among students. Learning opportunities should be used to encourage student progress in science (Ediger, 1994, 24-25).

Teacher Observation of Students in Science Achievement

Leadership is certainly needed from teachers and the school principal to use quality criteria to ascertain student achievement in science (Ediger, 1999, 1-5). Test results may well be worthless unless the standards used in measurement and evaluation to determine student science achievement possess face validity as well as reliability, such as test/retest, alternate forms, and/or split half. There are a plethora of factors which need to be incorporated into the writing of quality tests including being on the present reading level of students who will be taking the test. Individual differences should be provided for including variable time limits for students individually who need more time to complete a test.

To harmonize a hands on approach in teaching/learning in science with the assessment process, the teacher may use observational techniques The following criteria may be used in the observational process by the science teacher when students are doing hands on science —

1. how well a learner is identifying problems to solve in science.
2. how effective the student is in gathering information directly related to the problem.
3. how proficient the student is in achieving an hypothesis.
4. how well the learner does in testing and evaluating the worth of the hypothesis
5. how capable the student is in modifying the hypothesis, if necessary.

Teacher observation may be used to determine how well a student is doing in each of the five above named categories An additional vital item to observe is how well students are using science equipment and materials in problem solving experiences.

Metacognition in Science

Metacognition skills are important to use in the evaluation process. Metacognition deals with thinking about thinking Early in the child's school experiences, he/she should be aided to achieve as optimally as possible (See Allen, Spring, 2001). The science teacher needs to provide a model to assist students to reflect upon what has been achieved in science in an ongoing lesson or unit of study. This provides opportunities, not only to reflect upon what has been acquired, but also for the student to think about what is left to learn.

Motivational factors arise here in that the learner feels a sense of accomplishment as well as there being more to achieve. Relating that which has been achieved with what is left to learn makes for connections of the older learnings with the new. Review within the reflection process is a powerful factor in retention of subject matter, skills, and attitudes, as well as creating a desire to continue achieving. Too frequently, individuals believe that what has been learned will remain there for retrieval But forgetting and problems in retrieval are forthcoming. For metacognition to become an important factor in self evaluation, the student needs to —

1 be responsible for his/her own achievement in science.

2. trust the self, with teacher guidance to develop quality criteria in and for self evaluation.

3. lean upon the self to evaluate assess, and accomplish.

4. monitor the self to determine i science goals of instruction are being achieved.

5. rehearse, analyze, and synthesize objectives, learning opportunities and assessment procedures with each being vital in teaching and learning.

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Some Thoughts about a Mathematics Laboratory

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1. A mathematics Laboratory is primarily a laboratory in which experiments are performed with mathematical objects viz. numbers and geometrical shapes in order to discover patterns, make conjectures, do more experiments to verify the conjectures or to find counter-examples and if no counter-examples are found, to try to prove the conjectures. It is a place where the students get the thrill and excitement of discovering mathematical results which may not be new in mathematics, but which are likely to be new for the students.

There can be no mathematics laboratory without experiments.

2. Some persons regard a mathematics laboratory as a place where charts and models are made by students, teachers and even parents to make abstract ideas of mathematics relatively concrete and thus more easily understandable by the students. The students find preparing these charts and models an enjoyable experience and these make mathematics learning exciting to them. This activity also represents experimentation to find the best means of communicating mathematical ideas to young students.

3 In the same spirit, a mathematics laboratory is a place where in place of charts and models or in addition to charts and models, the students make use of calculators and computers to do experiments to learn mathematics faster and in a really enjoyable and thrilling manner. Here the students also use calculators and computers to do experiments with numbers and geometrical shapes in a much faster manner and this accelerates the process of discovery of new mathematical results.

4. Just as charts and models can enable students to visualize mathematics, computer graphics can also be used to visualise mathematics on the computer screen even better and faster. A mathematics laboratory is a place where mathematics teachers knowing computer graphics, can try to make excellent graphics visible and do experiment with them to choose those which are most important.

5. An alternative view of a mathematics laboratory is that it is a place where students are taught the *process of mathematics* rather than the *product of mathematics*. It is a place where they learn both experimental and theoretical aspects of mathematics in an integrated manner. Here they both make conjectures and prove them. Theorems are not just stated and proved, these are arrived at through experiments and the

method of proof is also clear from the understanding of the method in which the experiments are performed.

6. The mathematics laboratory can also be regarded as a place where problem solving and problem posing are emphasized much more than learning theory and solution of standard problems and even committing these solution to memory. Normally in the mathe-matics classroom, the teacher teaches the theory and solves some examples and the students are asked to attempt more problems at home, where they try to solve these problems by themselves or with the help of their parents and tutors.

7 In a mathematics laboratory, the students solve the problems in the laboratory itself. They can even discuss the solutions among themselves and they can try to solve the problems by different alternative methods of solution. When they get stuck up, they can get help from the teacher who examines their solutions, finds errors if any, and gives them hints for further solutions of problems. The teacher helps the students in their struggle to solve problems, but he does not spoon-feed the students by giving them complete solutions. Thus, in a laboratory, learning of mathematics takes place through interaction among the students themselves and the interaction of the students with the teacher.

8 In a mathematics classroom, a teacher speaks and the students listen. In the mathematics laboratory, students think, teacher does not speak, but helps the students whenever such help is needed

9. Mathematics laboratory is not a place where charts and models are stored. Such a place may be called a mathematics museum or a mathematics gallery, but it is certainly not a mathematics laboratory. A mathematics laboratory is a place where charts and models are made, it is not a place where they are stored. Similarly it is a place where computer programmes and computer graphics are made and not just bought and stored.

10 A mathematics laboratory can be compared to an artist's studio, where the artist experiments with artistic designs with paints and brushes. The gallery where he displays his art products can be compared to mathematics museum One can learn painting by working in a studio and not just by visiting an art gallery. Similarly one can learn mathematics more by working in a mathematics laboratory, than by visiting a mathematics museum.

11 Nobody learns to play cricket by seeing other players playing the game; one can learn it only by playing the game oneself on the cricket field, making mistakes in learning and improving style of playing. Similarly one can learn mathematics by working in a mathematics laboratory, solving problems, doing experiments and not by just studying solved examples alone.

12. In the same way, a mathematics laboratory can be compared to the classroom where music is taught and learnt rather than to a place where music cassettes are played.

13. In a mathematics laboratory student's and teacher's creativity and originality are at their best. In a mathematics classroom, there is almost no scope for originality and creativity. There it is all conformity to standard methods of leaning and teaching.

14 The object of teaching mathematics is to produce creative and original thinkers who can solve new problems with full confidence. All such new problems cannot always be solved analytically or theoretically. Students have very often to solve simpler versions of these problems experimentally and then try to generalise these solutions to get the solutions of the original problems.

15. Mathematics is as much an experimental science as physics or chemistry or biology Intuition and inductive logic play here also an active role However, in mathematics education, we do not place enough emphasis on the experimental method with the result that students develop math-phobia. However, in a mathemathical laboratory, students enjoy learning the process of mathematics and this joy counters the fear of mathematics that pure deductive methods instil in the students.\

16 Every experiment in a mathematics laboratory should have very clear-cut objectives These may include:

- A deeper understanding of the concepts already taught to the students
- Understanding of applications of mathematics
- Understanding some new topics which require only the knowledge of mathematics learnt in the classroom, but whose understanding will greatly enhance the joy of learning mathematics.
- Understanding some phenomena in the environment which are apparently mathematical, but which are not studied in the normal classroom learning.
- Giving mathematical experiences from which students can abstract results and see that mathematics is an abstracting science.

17. In a mathematics laboratory, students are actively, emotionally, intellectually involved in the learning process and whatever is learnt with such involvement is not easily forgotten and is fully assimilated by the students

18. In problem solving sessions in mathematics laboratories, senior students may be employed to help junior students in solving these problems This will be cheaper than using the regular teachers and this will also help the senior students in becoming clear about the concepts they have to explain to the junior students.

19. Mathematics laboratories can take the help of art and workshop teachers and others to improve the quality of the charts and models prepared by the students. Similarly they can take the help of computer scientists in the preparation of computer programmes and computer graphics for use in the mathematics laboratory.

20. Students have to record their experiments in practical note books in the same way in which they record the results of science practicals, that is they have to give the name of the experiment, objective of the experiment, equipment needed, method of carrying out the experiment, calculations done, results obtained, precautions necesseary and possible improvements in carryirig out the experiment.

21 In a mathematics laboratory students have to think, talk, discuss among themselves discuss with the teacher, interpret the results, think of new experiments and thus they become active partners in the learning process.

22. It is strange that all these years, in spite of our system suffering from mathphobia in a bus way, we have not thought of starting mathematics laboratories which can possibly remove the main causes of mathphobia

23. The mathematics laboratory is not yet a part of the examination system, though the NCERT in its National Curriculum Framework has recommended that a mathematics laboratory should be established in every school and in the examination scheme it should have the same weightage as science laboratories. However it is only a matter of time before the CBSE and other boards of secondary education include mathematics laboratory as a part of the examination system But whether they do it or not, our schools can start mathematics laboratories for students of all classes, except possibly 10th or 12th, immediately and arrange their time table in such a way that the students of each section of a school spend at least one period a week in the mathematics laboratory, doing experiments, discovering new results and learning the use of calculators and computers in solving mathematical problems and in discovering new results.

24. Introduction of mathematics laboratory may mean removal of some redundant topics from the syllabus. There are so many topics in the present syllabus which are being taught just because of tradition, but which have lost all relevance in modern times. We can easily find time for mathematics laboratory activites in the time table.

25. In foreign countries there are no separate mathematics laboratories, simply because every classroom is itself a mathematics laboratory since in these countries the teachers themselves examine their students and they ask their students to do mathematics practicals in the classroom and they give marks to the students for this work Most of their textbooks have sections on enrichment and mathematics practical activities and so they do not need separate mathematics laboratories. In our case since we have external examinations and the teachers cannot ask students to do mathematics practicals in the classroom, we have to have separate mathematics laboratories.

26. It is desirable that every teacher should also do laboratory work with his or her own students, but till such time as all the teachers can be trained to do this work in the right spirit some teachers may be designated as mathematics laboratory teachers and a

separate room for a mathematics laboratory may be allotted Students from different classes can go to this room in different periods and the laboratory incharge designs special experiments, for each class in consultation with the class teacher concerned.

27 Some schools have already included mathematics laboratory as a component of the socially useful productive work programme and many students prefer to take this component over others. Parents also like this because this activity strengthens the motivation of the students in learning mathematics and science

28 In many schools, with mathematics laboratories, it has been found that even if the experiments are not directly related to the syllabus, the joy that the students get in preparing charts and models and the thrill and excitement that they get in discovering new results themselves, enables the students to do much better in the normal classroom examinations After all motivation for learning a subject is an important factor for learning the subject and mathematics laboratory activities provide a great motivation for learning mathematics.

29 The expenditure on a mathematics laboratory is less than the expenditure on a science laboratory and mathematics laboratories can also be used in learning other science subjects.

30 Mathematics laboratories should also aim to bring mathematics closer to other school subjects and experiments can be designed to show the applications of mathematics in physics, chemistry, biology, economics, commerce, history and other school subjects. Mathematics across the curriculum can become a reality through mathematics laboratories.

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Science Practicals Ignored

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Sometime back I was appointed by the State Board of School Education, as an examiner to conduct examination on Chemistry Practical for the students of Class XII of a reputed college. As per the instructions given for the paper setter, the tasks assigned for the examination included a single salt for analysis and a volumetric exercise consisting of an acid-base titration. Each student was expected to write the procedure for doing the salt analysis and the equation(s) of the chemical reaction(s) involved therein. After distributing the answer sheets, the students were explained what was expected of them. Once the instructions were over, every student took up the exercise on titration To my utter surprise, none of them touched the salt. Their chemistry teacher was also present as an internal examiner and also to boost the morale of students. On my enquiry, the teacher told me that students normally avoid the analysis of salt. To encourage students to undertake analysis of salt, I even told them that they have the liberty to take the guidance of their teacher if they so desire, but this too did not cut much ice. At last, I told Laboratory Assistant to put the salt samples back in respective bottles and advised students to disperse.

I was left to wonder as to which direction are we marching in a free country. When I look at the gadgets, like refrigerator, TV, VCR, in my house, which are also commonly found to all other houses, I wonder how scientists like Faraday, Marconi, Einstein and others might have worked day and night to discover basic principles of science that ultimately led to the development of these gadgets. All this has become possible because of the hard work done by innumerable number of devoted scientists, technologists and other workers in their laboratories. In order to accomplish their objectives these men of science often worked in very adverse conditions, even designing their own apparatus or sometimes working with improvised apparatus. But their concern for the development of science and technology with the ultimate objective of serving the society was unmatched. One may recall that during the Second World War, Germany fell short of petrol and the leaders of the nation asked the top scientists to evolve a technique to synthesize petroleum A team of researcher workers namely Berguis, Fischer and Tropsch hydrogenated coal to accomplish this after trying many catalysts, different temperature and pressures. Similarly, scientists and technologists have developed a number of techniques to synthesize a large number of materials to meet the growing demand. At present, almost everything can be synthesized and made artificially, such as, fibre, plastics, dyes and the like. Haber, another German scientist, synthesized NH_3 by reacting N_2 from the air and H_2 from water—

$$N_2 + 3H_2 \xrightleftharpoons{Fe/Mo} 2NH_3$$

which is used to manufacture urea, and ammonium sulphate, one of the major components of fertilizers that paved the way for the green revolution in India.

Sum and substance of all this discussion is that greater emphasis should be laid on science practicals in schools not only to produce future scientists like Sir C.V. Raman, Dr J.C. Bose, Dr. Khorana but also to provide well-trained human resource to carry forward and sustain the development of the country in all walks of life. Our students are future thinkers, discoverers, and inventors. To successfully accomplish this role, it is imperative that the students should not only master basic laboratory skills in school but also learn how to design simple experiments to investigate a given problem.

For developing the interest of students in science practical, a proactive role of parents, teachers, educationists as well as administrators is a must. Each one of them can do their bit to improve the dismal conditions prevailing in schools at present. All efforts need be made to convince the students about the importance of laboratory work and the need to develop scientific aptitude and interest in the study of science. Teachers and parents should make conscious effort to encourage their wards to be curious, to raise questions and satisfy their quest for knowledge by answering their relevant queries or helping them to seek answers from different sources

One of the most important aspects of science, in my opinion, is that it is a joint enterprise. The discoveries and inventions made by a scientist or a team of scientists at any point of time in any part of the world form the basis for discoveries and inventions elsewhere during the same period or subsequently. There are innumerable examples in the history of science to bring home this point. The parents and teachers can encourage students to discover for themselves this interdependence of scientific enterprise. For example, it is well known that Newton discovered the law of gravitation, when he saw an apple falling on the ground and not going up He was guided to a great extent in his discovery by the work done by his predecessors like Galileo, Kepler, Copernicus and many others. Newton proposed the corpuscular theory of light and could explain reflection and refraction with it. His contemporary Hyghen proposed a wave theory for light and could explain successfully the phenomena of diffraction and interference After Newton, wave theory of light found favour with the scientists until it was established that light has a dual nature; it behaves like a particle as well as a wave. Similarly, Einstein further refined the Newton's law of gravitation when he proposed his theory of relativity. John Dalton's idea that the atom is the smallest particle of matter was modified once the existence of subatomic particles like electrons, protons and neutrons was established. These men of science could unfold the mysteries of nature because they could think differently and interpret the observations concerning a given phenomena in a way different than others. They then pursued their ideas further often through experimentation until they could establish them. Many a time they could not find evidences to support their ideas and had no hesitation in rejecting them. This, however, did not deter them in their pursuits because they were not afraid of accepting their mistakes.

In our schools, however, there is tendency amongst the science teachers to find one excuse or the other to avoid laboratory work or make demonstrations a part of their teaching in the class. One of the most common arguments given to justify their attitude is the lack of laboratory equipment and other resources available to them in schools.

Strangely enough, I know many a reputed public schools where students have never touched a chemical or performed any laboratory work in physics or biology The laboratories in these schools are well equipped to conduct not only prescribed laboratory exercises but also for teacher demonstrations in the classrooms but unfortunately costly equipment and apparatus gather dust in the cupboards and in the long run get rusted. A majority of teachers do not demonstrate even the simplest experiments in the class because of the fear of failure in front of their students.

This pathetic attitude of many science teachers ruthlessly kills the enthusiasm and spirit of students most of whom are too eager to work in the laboratories and do experiments. The administrators or the management of schools are usually interested in the overall performance of their students in the Board examinations and often this objective is achieved by lavishly entertaining the examiners and taking good care of them.

I have no intention to paint a poor picture of teachers for their apparent disinterest in providing adequate opportunities to our students to acquire and master laboratory skills but I simply wish to highlight the long-term impact of these unhealthy practices on the development of the scientific attitude amongst our future generations. There is an urgent need to curb this menace as early as possible which requires a concerted effort from all those functionaries who are involved directly or indirectly with the education of our children in schools. I conclude with quotations from Leonardo da Vinci and Albert Einstein on the importance of experiments in the development of science.

". those sciences are vain and full of errors which are not born from experiment, the mother of all certainty. .." (Leonardo da Vinci, 1452-1519).

"Bear in mind that the wonderful things you learn in your schools are the work of many generations, produced by the many enthusiastic effort and infinite labour in every country of the world. All this is put in your hands as your inheritance. In order that you may receive it, add to it and one day faithfully hand it on to your children. Thus, do we mortals achieve immortality in the permanent things, which we create in common

If you always keep that in mind, you will find meaning in life and work and acquire the right attitude towards our nations and ages." (Albert Einstein).

Science News

Insat-3C Launched

INSAT-3C satellite, built by the Indian Space Research Organisation (ISRO), was successfully launched early morning on 24 January 2002, by the Ariane-4 launch vehicle of Arianespace. The 147th flight of Ariane, carrying ISRO's 2,750 kg INSAT-3C, lifted off at 05:17 am IST from Kourou, French Guyana in South America. INSAT-3C was injected into a Geo-synchronous Transfer Orbit (GTO), 21 minutes after the lift-off, in a 3-axis stabilised mode, with a perigee of 570 km and an apogee of 35,920 km and an inclination of 4 deg, with respect to the equator. The satellite at that time was going round the earth with an orbital period of about 10.5 hours.

The INSAT Master Control Facility (MCF) at Hassan in Karnataka acquired the telemetry signal from INSAT-3C after nearly 30 minuts i.e. at 5:47 am IST. The initial health checks on the satellite confirmed that the performance of the satellite is normal Issuing commands from the Master Control Facility (MCF) at Hassan carried out first operations on this satellite. The outermost panel of the stowed solar array on the south side of the satellite was oriented towards the sun to start generating the electrical power required by the satellite during its transfer orbit phase. Subsequently, the earth viewing face was oriented towards earth and calibration of the gyros on board the satellite were carried out INSAT-3C was being tracked, monitored and controlled from MCF, Hassan, during the initial phase of the Operations. MFC also utilised INMARSAT organisation's ground stations at Beijing (China), Fucino (Italy) and Lake Cowichan (Canada) in these operations. The satellite's orbit has to be precisely determined by continuous ranging from the participating Telemetry Tracking and Command (TTC) stations.

The maneuvers for orbit raising operations on INSAT-3C were carried out by firing the 440 newton liquid apogee motor on board in stages till the satellite attained its final geo-stationary orbit, about 36,000 km above the equator. The satellite had about 1.5 ton of propellant (Mono-Methyl Hydrazine — MMH and Mixed Oxides of Nitrogen — MON-3) for orbit raising operations as well as for station keeping and in-orbit attitude control. The on orbit fuel availability will enable maintaining the satellite for operational services for a period of 12 years.

Deployment of the two solar panels and the two antennas was carried out when the satellite reached its near geo-stationary orbit and the finally the satellite has been put in its final 3-axis stabilised mode. The payloads will be subsequently checked out before the commissioning of the satellite.

INSAT-3C will be co-located with INSAT-1D at 74 deg East longitude. Other INSAT satellite locations are INSAT-2C and INSAT-2B at 93.5 deg East longitude, INSAT-2E ad INSAT-3B at 83 deg East longitude, INSAT-2A at 48 deg East longitude and INSAT-2DT at 55 deg East longitude.

INSAT-3C carries 24 C-band tranponders, six extended C-band transponders, two S-band transponders and a Mobile Satellite Service transponder operating in S-band up-link and C-band down link.

INSAT-3C has the main body in the shape of a cuboid of 2 × 1.7 × 2.8 m When the two solar panels are fully deployed in orbit, it will measure 15.5 m in length. The sun tracking solar panels generate 2.75 kW of power. Two 60 Ah Nickel-Hydrogen batteries support full payload operations even during eclipses INSAT-3C, like all its predecessors in the INSAT series, is a 3-axis body-stabilised spacecraft using momentum/reaction wheels, earth sensors, sun sensors, inertial reference unit and magnetic torquers. It is equipped with unified bi-propellant thrusters The satellite has to deployable antennas and three fixed antennas that carry out various transmit and receive functions

INSAT-3C is the second satellite to be launched in the INSAT-3 series The first satellite, INSAT-3B, was launched on 22 March 2000 INSAT-3C is expected to augment the present INSAT capacity for communication and broadcasting, besides providing continuity of the services of INSAT-2C when it reaches the end of mission life late this year.

With ISRO Satellite Centre (ISAC), Bangalore, as lead centre, INSAT-3C was realised with major contributions from Space Applications Centre (SAC), Ahmedabad, Liquid Propulsion Systems Centre (LPSC) at Valiamala and Bangalore, Vikram Sarabhai Space Centre (VSSC) and ISRO Inertial Systems Unit (IISU), Thiruvananthapuram. Besides, several industries in both public and private sectors have contributed to the realisation of INSAT-3C. The MCF is responsible for initial and in-orbit operation of all geo-stationary satellites of ISRO.

Physics-based Model For Doctors Handling Heart Cases

Dr. Richard Clayton and his team of researchers from the University of Leeds, U K. has developed a new computer simulation that allows doctors and physicists to model the faulty heart beats (arrhythmias) that can cause cardiac arrest, and run episodes of arrhythmia time and again, looking for the best way of treating it.

Speaking today at the Institute of Physics "Simulation and Modeling Applied to Medicine" conference in London, presents and demonstrates how his team's physics-based understanding of the heart could lead to improved treatment.

In presenting an overview of the project Dr. Clayton first explained how electric impulses behave in the functioning of a normal heart. According to him during a healthy heart beat, a wave of electrical activity sweeps through the heart muscle, moving from the inside towards the outer surface making the heart start to contract, before dying away. However, in the event of a cardiac arrest this normal pattern is disturbed. The electrical activity fails to die away properly, and moves around the muscle in a turbulent pattern causing an arrhythmia known as venticular fibrillation.

The detailed biophysical and anatomical model developed by the research team can simulate this activity and one can then test different pharmacological and physical treatments that could help the patient. The simulation requires massive computing power; even using high-speed equipment, it takes 24 hours to simulate one second of heart activity. The end result, however, is a sequence of colour images of the beating heart, showing the pattern of electrical activity and enabling researchers to visualize the effects of different therapies. At the same time, the model have the provision to simulate the electrical signals that would be detected by external monitoring devices and show how the particular state of the heart would appear in a clinical electrocardiogram trace. This allows their simulation system to provide information that will assit in day-to-day care of patients who are prone to venticular fibrillation following a heart attack.

Cholesterol Breakthrough !

Here is good news for cream and butter lovers from a group of Israeli scientists who say that they can now eat their favourite fat containing foods without feeling guilty about rising cholesterol level in their body. According to the scientists this would be possible due to a chemical process developed by them that removes cholesterol fromt the body.

Professor Nissim Garti, a chemist at Jerusalem's Hebrew University, has designed what he calls tiny "nano-vehicles" to deliver specific nutrients to the blood stream and inhibit the delivery of other molecules, such as cholesterol. According to Garti these vehicles can either be used to enhance transport of certain molecules or else to retard or to depress transport of other molecules. Garti's custom-made nano-vehicles transport phytosterols – plant fats believed to help combat cholesterol – to the blood stream instead of cholesterol.

Explaining their mode of functioning Garti said that the cholesterol is expelled through the digestive system and the body, which is incapable of utilizing them, discharges the phytosterols. The result is that after a few weeks of intake of these new vehicles, the levels of total cholesterol are reduced by 15 to 30 percent depending on the amount of daily intake The so-called vehicles, which Garti designs for each individual compound are about 5 to 15 nanometres and are made out of water, oil, an emulsifier and alcohol.

Stem-Cell Cloning Holds Promise in Cancer Research

In the near future a team of scientists in the United Kingdom will make the first application for a government licence to carry out the cloning of human embroys.

Literally opening a Pandora's box of medical wonders, although not without important ethical implications, their objective will be to initially use space IVF (in-vitro fertilization) embryos and later clone early human ones as the main component of research on embryonic stem (ES) cells, the parents of all cell types.

This research will offer the means to repair damage caused by Alzheimer's and Parkinson's disease, stroke, spinal cord injuries, heart ailments and diabetes.

The Bio-industry Association of the UK has said that human trials of ES treatment could start within three years. But the team at Sheffiled University, northern England, emphasized that they were not providing anything in the nature of a "quick fix".

Professor Peter Andrews of Sheffield University says that he finds it difficult to envisage routine use of the technology on other than selected volunteers in the next 10 years. He is the first UK scientist to work on human ES cell lines in culture His work follows extensive research of a peculiar type of tumour called a teratoma. These contain a haphazard mixture of tissues, such as bone, nerve and muscle, as if from an embryo whose development became catastrophically scrambled.

Lessdramatic but highly malignant forms occur more commonly as testicular cancers in young men Study of these cancers has led to the ability to grow ES cells as well as the prospect of their use as remarkable sources of tissue for transplantation therapy The malignancy of testicular teratomas is mainly caused by a stem cell known as an embryonal carcinoma (EC) cell. During the 1970s, lines of EC cells from mouse teratomas were established in culture. It was soon shown that EC cells closely resemble ES cells, the forebears of all the different cell types that make up the developing embryo

The way that both have the potential to turn into more specialized cell types — a process known as differentiation — was of particular interest to scientists interested in understanding how embryos develop. Indeed, it was through parallel studies of teratomas and embryos that scientists were eventually able to isolate ES cell lines directly from early mouse embryo.

Professor Andrews cautions that while many of the processes that control embryonic development are shared by mice and men, despite millions of years of separate evolution, some must be unique to humans. Therefore to understand better how human embryos develop and how the process can sometimes go awry, we must study human embryonic cell differentiation directly.

It was with this in mind that some 20 years ago, Professor Andrews and colleagues began to work with EC cells from human testicular teratomas, first at the Wistar Institute in Philadelphia, Unites States, and then at Sheffield University. One line that they studied, called NTera2, is particularly prone to differentiate into nerve cells, making it a useful tool for studying neurogenesis.

Scientists at the University of Pittsburgh are investigating whether or not transplanting neurons derived from EC cells into the brain can help alleviate the suffering of stroke patients. EC cells are cancer cells and there are concerns about whether their derivatives are truly "normal". This provided the basis of the recent excitement surrounding the successful derivation of human ES cell lines from "excess" embryos that would be destroyed following IVF treatment for infertile couples.

These are clearly different from mouse ES cells, underlining the importance of being able to use human ES cells to investigate human development. Such embryos have been used for the past decade for strictly defined studies on infertility, congenital disease or miscarriages, contraception and screening embryos for genetic defects.

The Sheffield team is to apply to extend its studies. Early embroys, consisting of 100 or so cells, would be dismantled to obtain their stem cells to see how they could be used to create heart muscles, blood cells and nerve cells.

ES cells may also provide a variety of tissues for the transplant surgeon. Much has recently been heard about "adult" stem cells and what they might achieve, implying that use of ES cells could be avoided. But we still have very little understanding of these and it is far from clear whether or not they will be as useful as some recent reports have suggested.

Professor Andrews asserts that it is likely that ES cells and adult stem cells will provide complementary tools; it is far too early to decide upon their respective benefits. In his opinion cloning technology adds very little at this stage. Ultimately, researchers may indeed find this approach useful to match ES cells to their potential donor. However, there is still much to be done to assess just what ES cells can do, first.

Courtesy: Spectrum online

Physicists defy Weakest Link

The newly discovered superconducting material magnesium borate has properties that will have important implications for use as a conductor and a high field-generating device.

Work done at Cambridge University, UK, by Dr David Cardwell and his colleagues have revealed that the complex material which behaves like ceramics has equalities that overcome problems many superconductors have— it is not particularly sensitive to the application of a magnetic field. According to Dr Cardwell this is a major breakthrough in this field with exciting implications for potential applications as both a conductor and a high field-generating device

Until the late 1980s, theory suggested that superconductors could not exist above minus 240 degrees celsius (°C) (approximately 30 kelvin). But a generation of so-called high-temperature superconductors was discovered in 1987 that were developed to superconduct at minus 107°C (166 kelvin).

The higher the electrical currents that a superconductor can carry at a given temperature, the greater its potential for use in everyday life. Superconductors are used for a variety of applications including magnetic resonance imaging and energy storage devices that provide a steady power supply for underground and overland trains.

Many of the high-temperature superconductors have serious drawbacks.

The complex metal oxides are both granular and brittle. When made into wires or other useful materials, it becomes difficult to pass current from one grain to the next.

These grain boundaries are effectively the weak links to the flow of electricity, severely limiting the application potential of the materials. Borate reveals that grain boundaries do not form weak links to the flow of current. The material also overcomes another problems is so much as it appears insensitive to the application of a magnetic field.

Courtesy: Spectrum Online

Knocking Out Function of Respiratory Virus Genes

Millions of children lose their lives every year all over the world due to asthma and respiratory illness caused by respiratory syncytial virus (RSV).

The results of a research study have shown promise to knock out the function of specific RSV genes by the use of synthetic inhibitory double stranded RNA (siRNA). This technique is expected to be exceptionally useful in furthering understanding of RSV and related viruses. In addition, it could lead to the development of new treatments to combat such viruses. Most organisms use double stranded DNA to store their genetic information. However, some viruses use single or double stranded RNA instead.

Among those that use single stranded RNA are RSV and the viruses responsible for influenza, measles, mumps, rabies, lassa fever and ebola. These organisms present unique challenges to researchers, as they cannot be studied using conventional genetic techniques, which are designed for DNA.

Vira Bitko and Sailen Barik from the University of Alabama, USA have used a technique called "post-translational gene silencing" whereby specific siRNA molecules are synthesised and used to target specific regions of the virus RNA. They have found that when siRNA was introduced into virus-infected cells, the production of specific viral proteins were blocked and replication of the virus could be efficiently suppressed. Furthermore, there was no detectable effect on the gene expression of the host cell, confirming that the technique is specific to the RNA virus. The researchers also showed tha siRNA acts by a mechanism that does not involve the interferon response that is triggered by viral infections.

Gene Therapy Research in Dentistry

According to a follow-up report by researchers, a significant progress has been made in gene therapy research, including treatment for head and neck cancers and repair of damaged salivary glands.

Dr Baum, one of the co-authors of the report and the chief of Gene Therapy and Therapeutics Branch, National Institute of Dental and Craniofacial Research (NIDCR) at the National Institute of Health, USA asserts that noteworthy advances in gene therapy relevant to dentistry has occurred since

1995 when he has co-authored an article on the potential impact of gene therapy on dentistry by the year 2015. The significant advances that find a place in Dr Baum's list include such areas as treatment for head and neck cancers, repair of bony defects caused by periodontal disease, trauma or surgery, and therapy for salivary gland dysfunction. His review in 1995 addressed initial efforts in three areas of orally related gene transfer research while the new review addresses seven areas of relevant research, and for all seven, substantive proofs of concept have been shown in animal models.

According to Dr Baum, cancer-related gene therapy appears effective as an adjunctive therapy for head and neck cancers. He further asserted that although current gene transfer methods are still considered to be fairly primitive, and associated with significant problems, gene therapy's acceptance as part of the routine clinical armamentarium, at least for some applications (like head and neck cancers), seems very close. Advances in salivary gland research, including NIDCR studies in animal models, show repair of damaged salivary glands and therapeutic applications to systemic diseases are possible through gene transfer technology.

Although applications of DNA vaccination are in the earliest stages, researchers are optimistic that these approaches will play a role in future strategies for preventing periodontal diseases and dental caries (tooth decay). In spite of considerable problems it is felt that gene therapy will have a pervasive and significant impact on areas of dentistry that are based in biological science and, by the year 2015, this will translate into dentists having a wide range of potential treatment options.

Plastic LEDs : A Breakthrough in Telecommunications with Widespread Applications in Fibre Optics Possible

In the past few years, polymers (plastics) that emit visible light have opened up exciting with the prospect of inexpensive and flexible products. However, the large optical telecommunications market seemed to remain outside the purview of these new light-emitting polymers because the plastics could not emit efficiently in the near-infrared (near IR) band where the optical fibres that carry the communications are most transparent.

Dr Nir Tessler and his team working at the Technion-Israel Institute of Technology in Haifa, together with Uri Banin and his team at Hebrew University in Jerusalem, has announced that they have been successful to get polymers that emit near-IR radiation. This has been accomplished by the researchers by incorporating tiny nanocrystals in the polymers Once commercialized, such nanocrystal polymers could potentially cut the costs of the hundreds of millions of telecommunications terminals needed to bring fibre optic communications to individual homes, opening the family doors to global networks.

Polymer light-emitting diodes (LEDs) are much cheaper to make than conventional solid state LEDs and lasers. In the conventional devices, materials are laid down in a vacuum and exposed to light through a patterned mask. Then part of the layer is removed by acid in a complex, multi-step process. But because polymers are soluble in various solvents (organic solvents, water, acetone), polymer layers can be sprayed onto materials with ink-jet printers, forming devices as the solvent evaporates in a much simpler and cheaper method. Visible light-emitting polymers already are being incorporated into products ranging from flat panel displays to infant mobiles.

Optical telecommunications, however, require near-IR radiation, for in this bandwidth optical fibres are almost entirely transparent. According to Dr Tessler, who was among the pioneers at Cambridge University in England, researchers believed that polymers could not efficiently produce near-IR radiation. This is so because the softness and flexibility (attractive features) of polymers are associated with vibrations (motion of atoms) on the molecular scale. These vibrations took off most of the energy of the radiation As a result the polymers or polymer-erbium composites produce near-IR radiation at a very low efficiency — around 0.01 per cent - far below that needed for economical operation.

Dr Tessler's solution to this problem is to incorporate nanocrystals of solid semiconductors into the polymer. The polymer is used to create the necessary device structures and the nanocrystals act as near-IR emission centres. On top of that says Dr Tessler, the polymer conducts the electricity to the nanocrystals, where the near-IR radiation is emitted. The nanocrystals are designed to have a shell of zinc selenium, which isolates a core of indium arsenide from the vibrations of the polymer, acting as a nano-scale shield (bumper). In this way, when the nanocrystals are made to emit near-IR radiation, the energy is not linked to the polymer vibrations and hundreds of times more radiation is produced. The Israeli team has demonstrated an efficiency of two to three per cent at a wavelength of 1.3 microns, within the range of interest in fiber optic tele-communications. Since the nanocrystals are dissolved within the polymer, the polymer-plus-nanocrystal solution can be ink-jet printed just as other polymers can.

The Technion and Hebrew University research groups now are developing different nanocrystal-polymer combinations to increase efficiency another ten-fold to the range of 20-30%. Researchers also expect to increase the wavelength to 1.5 microns, the best wavelength for telecommunications. Although further work is needed to produce the actual lasers for high speed fiber links, this new technology could pave the way for high-speed optical fibre links to every home.

Source: Stanford University (http://www.stanford.edu/dept/news/)

A New Method for DNA Detection

An innovative pairing of microelectrodes and probes of gold nanoparticle is at the heart of new technology that has been developed at Northwestern University, USA. The new technique simplifies DNA detection and in the near future could lead to a handheld device that is more accurate, less expensive and faster than conventional methods. "Nanotechnology can be used to get better results in all categories that are important in DNA detection — sensitivity, selectivity, cost, ease of use and speed, according to Chad Mirkin, Director of Northwestern's Institute for Nanotechnology. Mirkin who led the research team asserts that the electrical DNA detection method invented by them excels in all of these areas and has a good chance to become a truly disruptive technology.

The team of scientists used a synthetic sequence of DNA that models the anthrax lethal factor to test a technology that could displace polymerase chain reaction (PCR) and conventional fluorescence probes in clinical diagnostics and make point-of-care DNA testing possible in any doctor's office or even on the battlefield In this technique a simple electrical signal indicates that target DNA has been detected, and hundreds of pathogenic agents could be monitored, simultaneously. The new DNA detection method is unique as it eliminates the expensive and currently necessary step of heating the gene chip and also improves upon optical detection methods suggested earlier groups working at Northwestern Institute.

Once optimized, the technology could be used to quickly and easily detect biological weapons such as anthrax and smallpox as well as a wide range of genetic and pathogenic diseases, from genetic markers for cancer and neurodegenerative diseases to HIV and other sexually transmitted diseases. Results could be available in a matter of minutes instead of days.

The technology, which is yet to be fully optimized is 10 times more sensitive and 100,000 times more selective than conventional methods. It can pinpoint single-base mismatches that are missed by conventional fluorescence technology. This opens up opportunities in the rapidly growing area of single-nucleotide polymorphism (SNP) detection.

According to the researchers this system is based on conventional microelectrodes, tests could be produced for a fraction of what conventional technologies cost, also it takes a fraction of the time to process and interpret results. In contrast, the technique used currently, employs gene chips technology PCR coupled with fluorescence to do DNA testing. The gene chips are read using a confocal microscope, which is an expensive complex instrument. The whole process requires a long series of complicated steps.

Northwestern's electrical DNA detection method would eliminate the expense of PCR and fluorescence and allow testing for thousand of different biological targets on one chip. Using this method, various DNA tests can be placed on a glass slide, each test made up of single strands of synthesized DNA, or oligonucleotides, with a sequence designed to bind with its complementary target DNA. These "Capture" oligonucleotides are placed in between a pair of electrodes, one test for each pair. The slide then is placed in solution containing the target. Perfect and partial matches alike bind to the oligonucleotides on the slide's surface The gold nanoparticle probes, each covered with 200 oligonucleotide strands latch on to these pairings.

The probes are then amplified using modified photographic developing solution. Each gold nanoparticle becomes covered with silver and grows in size, closing the gap between the electrodes and carrying a current. The crucial next step is to eliminate the perfect match from a close match.

Temperature, or a thermal stringency wash, is the conventional tool for differentiating between the perfect and close match With the new methods, this complicated step is eliminated. Instead, a change in the concentration of a salt solution can be used to break apart any mismatches Only the perfect matches remain, allowing the silver-coated gold nanoprobes to carry a measurable electrical signal across the gap between electrodes.

The researchers made the important observation that these nanoparticle probes are very sensitive to changes in salt concentration, allowing them to replace the conventional thermal stringency wash with a "salt stringency wash "

The researchers made the important observation that these nanoparticle probes are very sensitive to changes in salt concentration, allowing them to replace the conventional thermal stringency wash with a "salt stringency wash."

To illustrate the superiority of their method, the researchers took on the challenge of what is called the "G·T wobble," a single-based mismatch of DNA that is difficult for conventional methods to distinguish from the perfect match of the target DNA. Such difficulty in discrimination can lead to false positives. The Northwestern method was able to distinguish between the match of two perfectly complementary DNA strands and the near-perfect match where just one base pair was wrong. The conventional fluorescence method would be unable to effectively distinguish the two.

In addition to clinical diagnostics, other applications of the electrical DNA detection method include SNP analysis, the fabrication of high-density electrical gene chips, and portable field sensors for the defense of biological warfare and terrorism

Book Review

Computales

Book Reviewed: *Computales*; Author: Homagni Chaudhari: Publisher· Indus (An imprint of Harper Collins Publishers India Pvt. Ltd.), 7/16, Ansari Road, Daryaganj, New Delhi-110002; pp. 86: Rs. 30.00

In the modern age, computers have indeed become indispensable. They have pervaded almost all parts of human activity and have become an integral part of man's everyday life. Examination results, telephone and electricity bills, railway reservation, bank statements etc. are all processed through computers. Computers are used even in watches, ovens, lifts etc.

Computers are electronic machines that perform calculations with incredible speed. Besides calculations, computers these days can also be used for creating graphics or even generating music. In fact, personal computers (PCs) have now become commonplace devices at homes, offices, banks and in schools.

However, it should not be forgotten that a computer has no brain of its own. It simply follows the instructions given to it in the form of programs, also called software. Therefore, given wrong information or data, the computer can be quite silly indeed. Technically, this is called GIGO, garbage in, garbage out.

Computer science now forms part of school curricula. Therefore, children have to work on computers not only in schools but at their homes also. However, some children become computer addicts in the process. Included in the collection of stories under review on computers, is a story titled 'Susmycin' that deals with the theme. Doily gets so much addicted that she always loves to sit in front of the computer terminal with the keyboard on her lap. Besides doing sums using the computer language Basic She is also able to draw pictures and cartoons on the computer terminal and play music through the speaker of the computer. Thus, computer takes all her time. Poor Doily comes in clash with the motto of her family that there is a time to work, a time to play, and a time for physical activity. However, Susmita—popularly called Shoot-Auntie, comes to Doily's rescue by writing program named Susmycin. Capable of curing the 'compu-addicts' the program later becomes in great demand. Indeed, a delightful story to read and enjoy.

Then, there are other stories in the collection that make quite an interesting reading The story titled 'The Runaway' is about a maths wizard Baboo who failing to score highest marks in mathematics in the class gets disgusted and decides to leave home for good. Along with Tobot, a child-care robot engaged to look after him, Baboo leaves the town in a truck. It is indeed delightful to read how Tobot succeeds in the final rescue act.

Overeaters may sometimes harass and spoil the mood of hosts. But a program named 'PARTY' may indeed come to the aid of such harassed hosts and prove a boon for them. Read on the story 'Hilsa' to find the answer how.

Remember the Y-2k problem that once plagued the computers the world over ? Though computers are wonderful they work on the instructions given by the user Sometimes, this may lead to silly situations also. For instance, in the story 'Late Fee', the library computer imposes an unbelievably heavy fine of Rs. 3,244.80 on Chumki for alleged late return of a book which actually has not even become overdue. Similarly, in the story 'Pishimoni and the Computer', 105-year old Annapoorna Debi, popularly called pishimoni, gets a form printed out by the village computer that demands to know 'why has she not been admitted to the village primary school' in spite of her having completed five years of age. A funny situation indeed but as the computer was programmed to recognise only the last two digits for age, it recognised only 05 instead of 105.

The appearance of virus in the hard disc may indeed plague a computer. The virus may enter into the hard disc through infected floppies. In fact, a virus is a small program, written by nasty people for their silly fun, to spoil the information on the hard disc. The problem posed by the virus is beautifully brought home in the story 'The Virus'.

The collection of stories under review has also a futuristic story, 'Freebird'. It centres round the concept of automation. 'Freebird' has its autonomous functions controlled by a sixty-four-bit microprocessor with thousands of nano processor chips controlling the individual functions. The expert software system HomAdmn is responsible for the coordination and overall administration. In short, the story is about a smart mobile home. But, one day shortage of a simple item like sugar puts HomAdmn into a fix. The story brings home the point that automation may not always prove blissful.

All the stories in the collection have been written in simple language and in an easy-to-follow style. Some technical terms followed in computer jargon like hard disc, floppy, virus etc. have been explained in the stories without taking recourse to technical language. All the stories are well illustrated with nice and delightful sketches. Leafing through the pages of the collection, children can indeed spend jolly good time. Certainly, the book will be able to make stories about computers popular among young readers

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Innovative Experiment : Verification of Boyle's Law

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Apparatus: Long transparent tube (~2 m) with marking on it for measuring the volume, Hanger with weights (200 gms), a balloon, thread, etc.

Principle

When pressure of a certain quantity of gas is changed, there is a change in its volume According to Boyle, for a given mass of gas, there is an inverse relationship between P and V, viz. $PV = \text{constant}$ for an ideal gas at constant temperature.

Thus, $PV = \text{constant}$

or $PdV + V\,dP = 0$

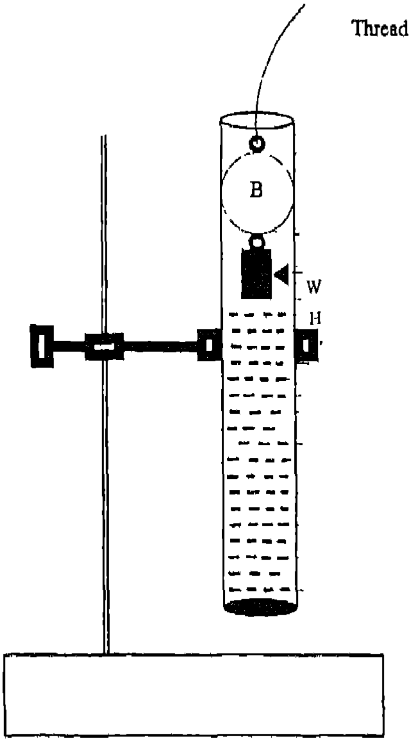
$\Rightarrow dP = -(P/V)\,dV$

or $dP/dV = -(P/V) = \text{constant}$ over a limited range of observations.

Setting Up of the Apparatus

For a low cost version take a fused fluorescent tube-light rod. Open it at one end and clear it off of its fluorescent powder so that it becomes transparent. Paste a graph paper scale along its sides and calibrate it in terms of volume. Fill the tube with water and set it in a vertical position with the help of a stand

Inflate a small balloon to approximately 30ml size and secure it with two knots on opposite sides. To one of the knots tie a hanger and to the other, tie a long thread. Next place the balloon-hanger assembly (with appropriate weights so that whole of it can dip into the water quite easily) into the tube such that the lower surface of the balloon just touches the water meniscus of the upper water surface as shown in Fig. 1. Note down the position of the meniscus H at this instance.



Notations:
B ⇒ Balloon
H ⇒ Level of upper meniscus
W ⇒ Weight

Fig. 1

TABLE 1

Sampie measurement with the set up

1 Inner diameter of the tube, $D = 3.5$ cm
$\therefore$ Area of cross section = 9 6 cm^2
And volume per cm on tube = 9.6 cm^3

2 Initial reading of the meniscus when the balloon just touched it, $H = 4\ 0$ cm.

3 Initial depth of the balloon when weight W was resting at the bottom of the tube

4 $d = 90$ cm.

5 Travelling Microscope reading rounded to two decimal places
Final reading of the meniscus when balloon was at depth d, $h = 1.10$cm
. Volume of the balloon $(H - h) = 4{,}0 - 1.1 = 2\ 9$ in cm units
[1 cm unit for volume = 9 6 cm^3]

Sl. No	d_i cm	h_i cm	Change in pressure $(d - d_i)$	Change in Volume $(h_i - h)$
1	80	1.12	10	0 02
2	60	1 17	30	0 07
3	40	1 23	50	0 13
4	20	1.28	70	0 18

Next draw the graph between $(d - d_i)$ versus $(h - h_i)$ where it runs from 1 to n, n being the integer corresponding to the serial number of the observations taken.

For convenience the nature of all the aforesaid graphs are drawn in Fig 3. The representative observations taken in this laboratory are included in Table 1.

Precautions

1. If a glass tube is used, take care that the assembly moves only slowly in the tube. A long straight transparent polythene tube will be better.
2. Since the change in volume expected is only small, a travelling microscope may be used for noting the meniscus level.
3. The size of the balloon should be in keeping with the size of the diameter of the tube.
4. Another set of readings can be taken with the change in the size of the balloon.
5. For better accuracy, volume of the empty balloon may be determined first.

Suggested Activity

Discuss the role of elasticity of the material of the balloon on the results of the experiment. Discuss what kind of result you expect if some other liquid replaces water. Can you do the experiment with salty water? Discuss how you can attribute the results to the purity of the water (liquids). The experiment can be performed with different gases inside the balloon.

Discuss how would you use effectively the same experiment with air bubbles in the liquid.

Laboratory Situation

Let us discuss what kind of problems an experimenter is likely to face while performing it in the laboratory.

1. If the cylindrical transparent tube is not sufficiently wide, the inflated balloon may not be immersed smoothly into the liquid in spite of using a hanger of larger weight, W. Hence, in such cases, use of cylindrical balloon is advised. One can use even cylindrical polythene bag and do the experiment.
2. If the area of the cross-section of the experimental tube is large, the change in volume at different locations of the balloon may not be noticeable. In such cases the use of either a longer tube or a higher density liquid (water with lot of salt) is advised. Further, as we know, volume of the balloon will be minimum when it is at the bottom of the tube, we may even conduct an additional activity as suggested: Fill the experimental tube to the brink while balloon is at the bottom. Next, lift balloon by 10 cm. This will cause increase in the volume of the balloon which will be reflected in overflow of liquid from the tube. The liquid thus split may be collected in a measuring jar for volume measurement.
3. To see the meniscus it may sometimes be useful to colour the liquid (or water).
4. Sometimes it will be better to see whether appropriate weight has been tied to the balloon by allowing the balloon assembly dip in the bucket full of liquid (water).

Conclusion

The simple experiment for Boyle's law can be used to conduct different investigatory projects suggested above.

Some Inverse Problems in School Mathematics

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Introduction

The present school mathematics is almost entirely concerned with the solution of *direct problems.* That is, given some axioms, we want to deduce some theorems by using deductive logic or given certain assumptions about a phenomena, we want to deduce some results which follow from these assumptions and so on. We do not consider the *inverse problems* of trying to find the axioms from which a given set of theorems, which may have been obtained empirically, can be deduced nor do we try to find out the causes which may have produced certain effects which have been observed. These inverse problems are relatively more difficult and unlike the direct problems, they do not have unique answers.

However, these problems are as -relevant to mathematics and science as the direct problems. In fact the importance of these problems in science, technology and industry is increasing. These are also important for mathematicians because these lead to very challenging, exciting, ill-posed problems in mathematics and their solutions require the development of new mathematical techniques.

The object of the present article is to investigate some inverse problems in school mathematics and show how the posing of such problems and attempts at solving these problems can provoke mathematical thinking, encourage mathematical reasoning and lead to new problems for investigation by students and teachers.

The First Set of Ten Problems

(i) Direct Problem : To find the sum of n terms of an arithmetical progression when first term a and the common difference d are given. Here the solution is easy and unique and we know that

$$S = na + n/(n-1)\, d/2 \qquad (1)$$

Inverse Problem : To find the number of terms n when S, and d are given.

To solve this problem we get the quadratic equation $n^2d+n(2a-d)-2S = 0$. It will give two roots which will be real and different, real and equal or complex according as $(2a - d)^2 + 8dS \gtreqless 0$. If both the roots are complex then there is no value of n for which the sum will have the given value S.

If the roots are real and equal, there will be only one value of n and that will give the number of terms, if it is positive. If the roots are real and different, then there will be one positive and one negative real roots if dS is positive and there can be two negative or two positive real roots when dS in negative.

As such there are a number of

possibilities for the solution of the inverse problem and we have to discuss each of these.

(ii) Direct Problem : Given the first term a and the common ratio r, find the sum of n terms of a geometrical progression.

The direct problem is easy and has the solution

$$S = \frac{a\left(1-r^n\right)}{(1-r)}, r \neq 1, S = na \text{ if } r = 1 \qquad (2)$$

Inverse Problem : Given a, r and S find out n. Here we get the equation $r^n = 1+S(r-1)/a$, or $n \log r = \log(1 + S(r-1)/a)$. If $1+S(r-1)/2$ is positive, we can find a unique real value of n, which may be positive or negative and will have to be interpreted. The inverse problem may have no solution or one positive solution or one negative solution.

(iii) Direct Problem : Given the first term a, the common difference d, the common ratio r and the number of term n, find the sums of the arithmetico-geometric series.

$$S = (a+d)r + (a+2d)r^2 + \ldots + \left(a + \overline{n-1}d\right)r^{n-1} \qquad (3)$$

To find the sums we multiply the series by r to get

$$Sr = ar + (a+d)r^1 + \ldots + \left(a + \overline{n-1}d\right)r^n \qquad (4)$$

Subtracting (2) from (1), we get

$$S = \frac{a}{(1-r)} + \frac{ar\left(1-r^{n-1}\right)}{(1-r)^2} - \frac{a + \left(\overline{n-1}d\right)r^n}{(1-r)} \qquad (5)$$

Thus given a, d, r and n we can easily solve the direct problem of finding S.

Inverse Problem : Here we are given a, d, S and either r or n and we have to find n or r. If we are given n, we get an equation for $n+1$th degree to solve for r. This creates the needs for solving equations of higher degrees. Students usually solve only quadratic equations of the second degree, but here they may have to solve equations of higher degrees. Thus if $n = 100$, they have to solve an equation of 101 degree. Thus the need for the solution of the inverse problems creates the need for studying the solutions of equations of any degree whatsoever.

In the other problem, we are given the value of r we have to find the value of n. In this case, we can plot the graph of S against the right hand side of (5), shown above, for various values of n and then by drawing a horizontal straight line from the point $(0, S)$, we can estimate the value of n. This creates the need of graphical solutions of equations and in this case the graphical calculators will be very useful.

(iv) Direct Problem : Given the principal amount P, the time T in years and the rate of interest per 100 per years time, find the amount of interest. This can easily be found by using the formula $I = PTR/100$.

Inverse Problem : Given the interest I, and any two of the three values P, T, r find the third. This can also be solved very easily by using the above equation and we obtain a unique answer in each case.

(v) Direct Problem : Given the principal P, the rate of interest r per hundred per unit time the time T and k the number of times in a year for which interest is compounded, find the component interest.

The direct problem is easily solved by using the formula $I = P\,(I + r/100\,k)^{KT} - P$.

Inverse Problem : There are four inverse problems corresponding to each of the four quantities to be found out viz *T*, *r* *k* and *P* when the interest and three other quantities are given. Here difficulty will arise only in finding *k*. This can also be done by using the graphical method of solution.

(vi) Direct Problem : Given *r* and *n* find n_{cr}. This is easy to solve since

$$n_{c_r} = \frac{n(n-1)\ldots(n-r+1)}{r!} \qquad (6)$$

Inverse Problem : Given n_{c_r} and either *r* or *n* find the others. If *n* is given, we get two values for *r*, since $n_{c_r} = n_{c_{n-r}}$, but no positive integral values of are may lead to the given value of n_{c_r}

Given *r*, we get an equation of the rth degree in n, but we can easily obtain its solution by using the graphical method but the value of *n* may not come out to be an integer. If it is not an integer, we have to interpret the solution in a special way.

(vii) Direct Problem : Giving *n*th term of a sequence, find any particular term. This is easily solved by giving the particular value to n.

Inverse Problem : Given n terms of a sequence find (*n*+1)th term. There is no unique answer to this problem. Thus given the sequence 2, 4, 8, 16, 32...the next term in the sequence will be 64, if terms in the sequence are in geometrical progression, but the next term will be 57 if the sequence is determined by a polynomial of the fourth degree in n and the next term can be any arbitrary value if the sequence is determined by a polynomial of the fifth or higher degrees.

(viii) Direct Problem · Given *x*, find sin x This has a unique solution which can be found by using trigonometric tables or scientific calculators.

Inverse Problem : Given the value of sin x, find x. This has an infinity of solutions, but if we consider only the principal value of $\sin^{-1} x$, we get a unique solution.

(ix) Direct Problem : Given a triangle, find the radius of it in-circle. The solution is given by

$$r = \frac{D}{S} = \left(\frac{(s-a)(s-b)(s-c)}{s}\right)^{1/2} \qquad (7)$$

where $s = (a + b + c)/2$

Inverse Problem : Given the in-radius r, find the lengths of the sides of the triangle.

Since

$$r^2 = \frac{(b+c-a)(c+a-b)(a+b-c)}{4(a+b+c)} \qquad (8)$$

given r and the lengths of the two sides of a triangle, this equation determines the third side, so that in general there will be a double infinity of triangles having the same in radius r.

(x) Direct Problem · Given the lengths of the sides of cyclic quadrilateral, find its area. The area A is given by

$$A^2 = (s-a)(s-b)(s-c)(s-d),$$
$$s = (a+b+c+d)/2 \qquad (9)$$

Inverse Problem : Given the area of a cyclic quadrilateral, find the lengths of its sides. It is obvious that given three sides, we may be able to determine the fourth side from the above equation, so that in general there will be a triple infinity of cyclic quadrilaterals having the same area A.

Second Set of Ten Inverse Problems

(xi) Direct Problem : Given any two points, find the equation of the straight line joining them. If the two points are x_1, y_1 and x_2, y_2 the equation of the straight line is given by

$$\frac{y-y_1}{x-x_1} = \frac{y-y_1}{y-y_2} \qquad (10)$$

Inverse Problem . Given the equation of a straight line and coordinates of one point on it, find the coordinates of other points on the line. If x_1, y_1 is the point, the equation if the line is

$$\frac{y-y_1}{\sin\theta} = \frac{x-x_1}{\cos\theta} \qquad (11)$$

where $\tan\theta$ is determined from the equation of the given line, so that the coordinates of any other point on the line are given by

$$x_1 + r\cos\theta,\ y_1 + r\sin\theta,$$

so that for different value of r, we get an infinity of points on the line.

(xii) Direct Problem : Given *f(x)* find its derivatives *f(x)*. In general the solution of this problem is unique, but the derivative may not exist at some points.

Inverse Problem : Given a function *f(x)* find its primitive, that is find another function *g(x)* whose derivative is the given function *f(x)*. If the function *f(x)* is continuous, we shall get an infinity of solutions differing by arbitrary constants, but the primitive may not exist in the class of elementary functions.

(xiii) Direct Problem : Given two vectors find their scalar and vector products. The solutions are unique namely, A.B = ab cosθ, $A \times B = ab \sin\theta\, \hat{N}$, where a and b are the magnitudes of the vectors A and B, q is the angle between them $\hat{N}$ is a unit vector perpendicular to both A and B in a right the handed screw direction,

Inverse Problem · Given the scalar and vector products of two vectors, find the vectors. The two vectors will lie in a plane perpendicular to the vector $\hat{N}$. We can also find ab and θ. It is obvious that we can have an infinity of vectors having given scalar and vector products.

(xiv) Direct Problem : Giving a square matrix A, find its eigen values. The solution is simple, since the eigen values are the solutions of the equation $|A - \lambda I| = 0$ where *I* is the unit matrix of the same order as the given matrix.

Inverse Problem : Given the eigen values $\lambda_1, \lambda_2, \ldots\ldots, \lambda_n$, find the matrix. One solution of the inverse problem is the matrix.

$$\begin{pmatrix} \lambda_1 & a_{12} & a_{13} \cdots\cdots & a_{1n} \\ 0 & \lambda_2 & a_{23} \cdots\cdots & a_{2n} \\ \ldots & \ldots & \ldots\ldots & . \\ 0 & 0 & 0 \ldots\ldots & \lambda_n \end{pmatrix} \qquad (12)$$

It can be verified that this matrix has the eigen value values $\lambda_1, \lambda_2, \ldots, \lambda_n$, whatever be the values of a_{ij}'S. Thus it is obvious that there is an infinity of square matrices which give solutions of the inverse problem.

(xv) Direct Problem : Given an $m \times n$ matrix A and an $n \times 1$ matrix, find the a matrix B = AX. The solution is simple since we have to multiply two matrices.

Inverse Problem : Given A and B, find X. You can write the solution as $X = A^{-1}B$, provided the inverse of the matrix A exists. If it does not exist, this problem needs the creation of the new mathematics of generalized inverse matrices.

(xvi) Direct Problem : Given two matrices A and B, find their product. This can be done provided the number of columns in A = number of rows in B.

Inverse Problem : Given the product of the two matrices, find the matrices themselves. If a_{ij}, b_{jk}, c_{ik} are the elements of the matrices A, B and C. Then

$$\sum_{j=1}^{n} a_{ij} b_{jk} = c_{ik}, \qquad (13)$$

and we get as many equations as is the product of the number of rows of the first matrix and the number of columns of the second matrix. These equations may not be sufficient to determine all the elements of the two matrices and we may get an infinity of solutions of the inverse problem.

(xvii) Direct Problem : Given the equation of the curve $y = f(x)$ find the area bounded by $y = f(x)$, $x = a$, $x = b$, $y = 0$. The solution is straightforward and is given by

$$A = \int_a^b f(x)dx \qquad (14)$$

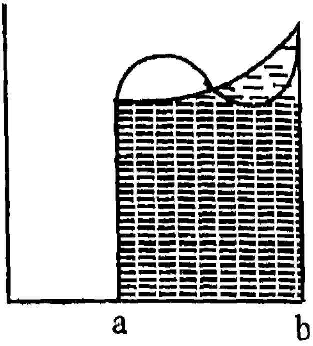

Fig. 1

Inverse Problem : Given the area under the curve find the curve. It is obvious from Figure 1 that there can be an infinity of curves enclosing the same area.

(xviii) Direct Problem : Given a curve $y = f(x)$ find the length of the curve between $x = a$ and $x = b$. The length of the curve is given by

$$\int_a^b \left(1+\left(\frac{dy}{dx}\right)^2\right)^{1/2} dx \qquad (15)$$

so that given a curve we get a unique length.

Inverse Problem : Given the length of the curve between $x = a$ and $x = b$, find the equation of the curve. It is obvious from Figure 2 that we can have an

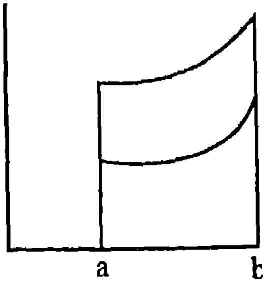

Fig. 2

infinity of curves having same length between $x = a$ and $x = b$.

(xix) Direct Problem : Given the curve $y=f(x)$ between $x=a$ and $x=b$ find the volume of the solid of revolution formed by rotating this curve about the axis of x. The solution of this direct problem is simple and is given by

$$V = \int_a^b \pi y^2 dx \qquad (16)$$

Inverse Problem : Given the value of the volume obtained by rotating a curve between a and x as a function of x, find the equation of the curve. Here we get the equation

$$\int_a^x \pi y^2 dx = g(x) \text{ where } g(x)$$

is a known function of x. Differentiating this equation, we get $\pi y^2 = g(x)$, so that y is determined as a unique function of x. Thus in this case the inverse problem has a unique solution, if the volume is known for all values of x.

(xx) Direct Problem : Given a function $y = f(x)$ obtain the area of the surface of revolution when the curve $y = f(x)$ is rotated about the axis of x between the ordinates $x = a$ and $x = b$. This direct problem has the solution.

$$S = \int_a^b 2\pi y \sqrt{1+\left(\frac{dy}{dx}\right)^2}\, dx, \qquad (17)$$

so that we get the unique value for S

Inverse Problem : Given the value of S when the curve is rotated between the ordinates a and x as a function x, find the equation of the curve. Here we get the equation

$$\int_a^x 2\pi y \sqrt{1+\left(\frac{dy}{dx}\right)^2}\, dx = h(x) \qquad (18)$$

where $h(x)$ is a known function of x. Differentiating, we get

$$2\pi y \sqrt{1+\left(\frac{dy}{dx}\right)^2} = h(x) \qquad (19)$$

so that we get a differential equation to determine y as a function of x, so that in this case also the inverse problem has a unique solution (except for an arbitrary constant) provided we are given the surface area for every value of x.

Other Sets of Ten Pairs of Problems

We leave their formulation to the readers. We hope they will be able to formulate such pairs after examining the above examples carefully and consulting either of the following references.

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Teaching of Light up to Secondary Level

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Teaching of light at the secondary and pre-secondary stages of school education is quite a challenging task. It is so because although we are surrounded by light all the time, yet the nature of light is difficult to explain in simple terms. The topics on light that are usually included in the syllabi of science at the secondary and the pre-secondary levels are the following:

(i) Nature of light
(ii) Mechanism of sight
(iii) Laws of reflection and refraction
(iv) Elementary ideas about interference, diffraction and polarization.

Here an attempt has been made to highlight some of the common misperceptions prevailing amongst students as well as the teachers concerning some basic concepts of light besides providing relevant tips for their teaching/learning. The dual nature of light and also its connection with the theory of relativity has been brought out in a simple way towards the end with a view to provide related content enrichment for the teachers of this stage of education.

Nature of Light

Idea of discussing something about the nature of light occurred to me due to an interesting and eye opening anecdote. The teacher trainees of our institute, as a part of their practice teaching, are assigned different schools. One of the accepted practices is that the trainees discuss the lesson plans prepared by them with the teacher of the local school who is designated as cooperating teacher. On one such occasion, a trainee teacher in his lesson plan has mentioned electric bulb and tube light as examples of light energy. However, the cooperating teacher was not in agreement with this opinion. In his opinion the two examples pertained to electrical energy and not light energy. Here it seemed that thought process of the cooperating teacher laid more stress on the nature of the primary source of the energy but not on the final product, that is, light energy. On the basis of that kind of argument, even the sunlight, which the cooperating teacher in the present case was willing to accept as the correct example of light energy, would be an example of nuclear energy.

The situation can perhaps be remedied if the teachers understand that the energy existing in the form of electromagnetic waves with their wavelength, lying in range, extending from about 400 nm to 750 nm, called the visible region, is familiar to us as light. Light is considered to be a form of energy because it can do work as is evident from the solar cells that convert light energy into electrical energy. The solar cells as the students of the secondary and pre-secondary stage know, are used to operate calculators, lighting systems and also tiny motors. It is the electricity generated by the solar cells that is used by the satellites to operate most of the systems installed in them. In satellites a large array of solar cells called solar panel, convert the energy of light into electricity to meet the energy requirements of the satellites.

For the sake of completeness it may be recalled that the electromagnetic waves comprise mutually perpendicular fluctuating electric and magnetic fields moving through space which in turn are both perpendicular to the direction of propagation of light or the direction of the more popularly known light ray. So one can imagine fluctuating and mutually perpendicular electric and magnetic fields moving through space at every point on the path of a ray of light which itself is perpendicular to both the fields. Thus, light is propagated as a transverse electromagnetic wave. We, as teachers, often tend to neglect this aspect of nature of light. This is because in studying ray optics or wave optics in undergraduate classes, an understanding of the wave nature of light is not considered to be an essential condition. For this purpose, it is sufficient to accept light as wave motion to deal with whatever is there in the course. Although to study polarization suddenly one has to take into account the transverse nature of the electromagnetic waves including that of light. Otherwise to explain the phenomena of interference and diffraction even the transverse nature of electromagnetic waves need not be presupposed.

Mechanism of Sight

The act of seeing or the sense of perception, which primarily makes us aware of the presence of light and helps us to define light as that which makes things visible, needs to be clearly understood. In this connection I refer to an interesting question posed in the NCERT textbooks of Class IX (1988) while discussing the defects of vision, which states that the human eye is normally compared with a photographic camera, but in real practice the scientists would rather say that comparison with a video camera is more appropriate. This is really true, because the image that is formed on the retina is communicated to the brain in the form of electric impulses. The later interprets the messages received in the form of electrical impulses and thus completes the act of seeing and perception. In a photographic camera the shutter is opened for a small time during which the film is exposed and a permanent record is obtained on it. On the other hand, the image formed on the screen of a video camera is in the form of a series of electrical impulses that can be manipulated with the electronic circuits. The image of an object in this form can be simultaneously processed for transmission or for recording on a video tape. Mechanism of vision in humans is closer to this.

Another conceptually intricate notion related with the sensation of sight is that we see objects only when light gets reflected from them and enters our eye. On the face of it this statement is not incorrect but the children, pupils and laymen alike often think that the light gets reflected from the objects in a similar manner as from a plane mirror or any other plane-reflecting surface. However, usually we see objects because they scatter light in all directions, which in a simplified form can also be considered as diffused reflection.

When a beam of light falls obliquely on a plane mirror or any other smooth plane reflecting surface, the beam gets reflected in a particular direction as expected according to the laws of reflection. However, such perfectly reflecting ideal mirrors or surfaces do not exist. Even an apparently perfect mirror reflects some light in different directions as well. That is why it becomes visible to us. A perfect mirror would be invisible, because it just changes the direction of light in which you view the light from an object reflected by it. This phenomenon could be verified by taking photograph of a candle and its image formed by a good quality plane mirror in a darkroom with a white board to provide a background. The photograph would show the candle and its image but the mirror will appear as a black patch in it. One such photograph has been printed on page 191 of the Indian edition of the book titled 'Physics' prepared by the Physical Sciences Study Committee (popularly known as PSSC Physics) and reprinted by the NCERT (1966). One can use this photograph as a suitable teaching aid. The study of such a photograph would clearly indicate that the luminous sources and all objects, which scatter light in a diffuse manner, are visible but a perfect mirror remain invisible. A number of pupils and teachers on various occasions have been asked to tell what do they think a mirror would look like if a photograph is taken with the arrangement described above. Most of them say that the mirror would appear as a bright spot!

In this context it may not be out of place to mention that some research studies also show that many children, especially at primary or elementary level, think that the rays of light emanating from the eye fall on the object and the object become visible when these are reflected back to the eye. This perception about light, however, can be investigated separately by framing a suitable questionnaire.

Laws of Reflection and Refraction

In teaching about the laws of reflection and refraction, it is essential for the teacher to emphasise the implications of statement of each law. One of the laws says that the incident ray, the reflected or the refracted ray and the normal at the point of incidence, all lie in one plane. Usually in teaching about this law in the classroom, the teachers often just state it and the same is reproduced by the learners wherever asked to do so. While stating the other law, that is, the relation between angle of incidence and angle of reflection or refraction, a diagram is generally drawn on the black-board without pointing out that the two rays and the normal lie in the plane of incidence. However, in order to develop a proper understanding of the law concerning co-planer nature of the incident ray, reflected or refracted ray and the normal, a three-dimensional view of a mirror, the normal and incident ray could be discussed. With the help of a three-dimensional geometrical figure, it could be shown that an infinite number of lines could be drawn with respect to a normal at a point such that each makes the same angle as the incident ray. Imagine a ray incident on a plane mirror kept on a horizontal table Suppose the angle, which the ray makes with the normal to the surface drawn at the point of incidence, that is, the angle of incidence is θ. Now one should understand that there could be an infinite number of straight lines, each making an angle θ with the normal. All these straight lines including the one that corresponds to the incident ray make a cone whose axis is the normal at the point of incidence. One can use a suitable cone made of paper to drive home this idea. Although all the lines on the cone make an angle θ with the normal, only the straight line on the other side of the incident ray lies in the plane of incidence and it is this line that gives the direction of the reflected ray. It should also be stated that the reflection of light is just like the reflection of a ping-pong ball from the table or the reflection of a striker from the sides of a carrom board.

Another important point to be borne in mind while teaching about reflection at spherical surfaces as well as refraction through lenses is that it must be emphasized again and again that the same laws of reflection and refraction are also obeyed in these cases as well. Normally pupils think that these laws are applicable only in the case of reflection and refraction at plane boundaries. It must also be made clear that the normal at the point of incidence has different directions at different points in case of curved boundaries. The special rules suggested to trace the path of a ray after reflection or refraction at a curved boundary are, in fact, derived using these basic laws. In pupils' mental framework often the rules become so predominant that laws of reflection or refraction become non-existent. Another misleading idea most pupils and some times even teachers may have is that only two or three rays emanate from a point on the object to form its image by a spherical mirror or lens. These two or three rays are those whose directions are predicted by the given rules. In fact a few selected incident rays are chosen just to locate the position of the image with respect to a point object. Once the position of the image of a point is located, it follows that all other rays emanating from that point on the object in any direction would pass through the same point after undergoing reflection or refraction. This can be easily verified by drawing a ray diagram for the case of image formed by a plane mirror. In case of spherical mirrors it is rather cumbersome to draw the reflected ray corresponding to any incident ray following the laws of reflection. This is because the normal to the surface at every point of incidence has a different direction. Whereas the geometrical

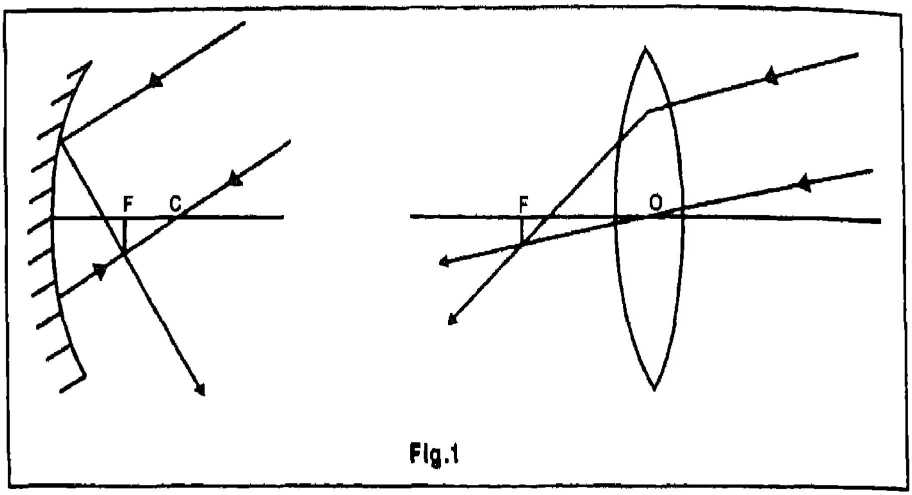

Fig.1

method is most convenient because only the rays parallel to the principal axis or those passing through the focus or the centre of curvature are chosen to trace the path of incident as well as the reflected or refracted rays. This method has been illustrated for reflection as well as refraction in Figure 1 for parallel rays which are inclined to the principal axis.

The rules on the basis on which the above diagrams are drawn are known to a majority of students. However, they often tend to forget that these rules actually follow from the laws of reflection or refraction and the geometrical properties of the sphere of which spherical mirrors and lenses may be considered to be a part. For example, a ray passing through the centre of curvature of a concave mirror gets reflected along the same path because the line joining the centre and the periphery of a spherical surface is always normal to that surface

Interference, Diffraction and Polarization

Although the study of the *phenomena* of interference, diffraction and polarization are usually not in the syllabus of science for the secondary and pre-secondary levels, it may be useful to acquaint the students with some elementary ideas about them. Pupils' common observations and naturally curiosity should to be curtailed just because certain topics are not considered suitable for inclusion in the syllabus. After all pupils do enjoy the spectacular view of a colourful rainbow. They often also observe patterns of coloured light patches of oil spilled on a wet road. Explanation of such observations cannot be given only on the basis that ordinary white light consists of light of several colours. Perhaps it may be more logical to tell inquisitive pupils that the phenomena of light responsible for these observations is not due to the composition of white light alone but also due to refraction, total internal reflection or inference about which they shall study later. In case of a rainbow, refraction is mainly responsible for the appearance of beautiful arch of coloured lights while the patterns of colours on an oil patch are due to interference of light. An elementary idea about interference can be given by inviting attention of the students on the interference pattern seen due to the waves on water in a trough, a tank or a pool when disturbances at two nearby points are produced in it. Another common example of the phenomenon of interference of water waves can be seen in a tank at the base of a fountain where disturbances are produced by the water jets falling near each other

The students can be helped to observe the phenomenon of diffraction through extreme narrow gaps between their closed fingers. When one looks through such gaps towards a bright source of light such as a fluorescent tube or sunlight hair-like dark lines can be seen due to diffraction of light. It may appear that the phenomenon of polarization cannot be observed without access to an elaborate system of polarisers and analysers. But there is a way out. Polaroid glasses used for spectacles-are common. These glasses are not coloured but still restrict the transmission of light through them because they allow only one kind of light. Naturally, question arises how does one find out whether a given spectacle has Polaroid glasses or not. For this purpose we have to have a polarized source of light to us in the form of blue of the sky, which is most prominent in the morning and the evening So, if we look towards the blue of the sky through the glass of a pair of spectacles and rotate it through 180°, a variation in the intensity of light could be seen in the case of Polaroid glass. However, if it happens to be ordinary glass, variation in intensity will not be seen. One may obviously wonder how the 'skylight' happens to be polarized However, readers can take it as an exercise and find an answer to this question.

Conclusion

The last intriguing thing about light, which would like to discuss in order to conclude, is the dual nature of light and its connection with the Theory of Relativity. It is very difficult to put across these ideas to the pupils at the secondary or pre-secondary level. The experiments on photoelectric effect and the complete explanation of the blackbody spectrum led to the hypothesis that light is emitted and absorbed as particles called photons But the photons could not to be considered to be like ordinary particles or the kind of particles proposed by Newton as *corpuscles*. Why a photon should be considered as different is immediately understood when we seek to know its energy, which is taken as $h\nu$. Now ν is called the frequency, which is a wave characteristic. So photon is a particle whose energy is to be described by a wave characteristic. So in a photon dual nature of light is in-built as in the De Broglie particle whose momentum is expressed as h/λ, where λ is the wave characteristic of the associated wave. So we must understand that both the following statements are correct:

1. Light consists of electromagnetic waves;
2. Light is emitted, absorbed and even propagated as photons.

Electromagnetic wave is nothing but the De Broglie wave associated with a photon. Even disregarding the experiments on blackbody radiation and photoelectric effect, if one compared electromagnetic waves with other waves in material media one finds that the energy of the waves in material media is nothing but the energy of the particles of the medium. In this sense the concept of energy is essentially a particle concept. Now light is an electromagnetic wave, which does not require any medium for its propagation but is still endowed with energy This idea should naturally led to the postulate that light may also be particles in disguise of wave. In the Theory of Relativity we learn about another amazing aspect of these waves that their velocity is independent of the source and the observer, which is unthinkable for sources of mechanical waves in a material media. To comprehend this we may recall our experiences while boating. If the boat is stationary and one drops a stone in the lake, the waves appear to more away in the form of concentric circles indicating that they are spreading at a uniform rate in all directions. Now if one repeats the same experiment when the boat is moving, an observer in the boat will find that now the waves are not moving in the form of concentric circles. So one may conclude that the velocity of the wave on water surface depends on the velocity of the observer. Yet in case of light it has been experimentally found that the light waves travel away from a source only in the form of concentric spheres irrespective of the velocity of the source or that of the observer. In order to comprehend this rather complex situation one has to accept that time and space are not independent entities but there is something like space-time and it is light, which connects them!

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Convection and the Newton's Law of Cooling : Some Misconceptions

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IN THE process of convection, due to the movement of the fluid particles, convection currents are set up in the body of the fluid. In free or natural convection, the convection currents may develop quite naturally. However, they may also be formed artificially by external means, such as fans and pumps, as in the case of artificial or forced convection. Airconditioning is the simplest example of the process of forced convection Central heating of rooms and the cooling of an automobile engine by blowing cold air on to it provide some other examples of forced convection.

In natural convection, as the fluid is heated, its density diminishes and it moves on account of the force of buoyancy acting on it because of the presence of gravity. Natural convection is, therefore, a consequence of gravity and always takes place vertically, carrying the heat upwards.

Natural Convection and the Five-fourths Power Law

The experimental studies on free or natural convection from a hot body into a gaseous atmosphere were first carried out extensively by Dulong and Petit in 1817. They observed the cooling of a large mercury thermometer, initially heated to 350°C, and placed in a large copper globe of about 30 cm diameter. The latter was blackened from inside and placed in a water bath which could be maintained at any desired temperature.

The copper globe was first evacuated by means of a vacuum pump attached to it and the rate of loss of heat due to radiation alone determined for various temperature differences. The thermometer bulb was again heated and replaced in the globe, now filled with a gas at a known pressure, and the rate of loss of heat was determined as before On the basis of these measurements, the rate of heat-loss due to convection along could be easily estimated. This enabled Dulong and Petit to arrive at an empirical law. According to this law, the rate of heat-low due to convection alone is given by

$$\frac{d\theta}{dt} = -k(\theta - \theta_0)^{1.233}$$

where θ is the temperature read by the thermometer at any instant of time t and θ_0 is the temperature of the enclosure, the parameter k depending on the gas and its pressure.

On the basis of theoretical considerations, Lorenz showed in 1881 that the rate of heat-loss by convection, that is, convective loss, for a vertical surface is proportional to $(\theta - \theta_0)^{5/4}$ or

$(\theta - \theta_0)^{1\,25}$ which is usually referred to as the five-fourths power law. This law, as can be seen readily, is not very much different from Dulong and Petit law, according to which heat-loss is proportional to $(\theta - \theta_0)^{1\,233}$.

Further experimental evidence in favour of the five-fourths power law came from Langmuir in 1913 who investigated the rate of cooling, in still air, of an electrically-heated large and flat vertical metal disc of about 20 cm diameter. The disc was highly polished and silver-plated to minimise the loss of heat by radiation. Taking measurement for various temperature differences, Langmuir found that, up to temperature differences of 600°C, the rate of heat-loss was given by the five-fourths power law deduced earlier by Lorenz:

$$\frac{d\theta}{dt} = -k(\theta - \theta_0)^{\frac{5}{4}}$$

This five-fourths power law, therefore, seems to govern the physical process of free or natural convection in still air.

Forced Convection and the Newton's Law of Cooling

Newton studied the cooling of hot bodies in a steady draught of air. Under these conditions, the loss of heat takes place essentially by forced convection although some loss of heat does take place by radiation as well. Newton found that, in a steady draught or air, the rate of cooling of a body is proportional to its excels temperature over that of the surroundings. This is known as the Newton's law of cooling.

Newton's (cooling) law has been found to hold good by a number of workers under conditions that the loss of heat by radiation is small as compared to that by convection. In a strong draught of air (i.e. when the velocity of the air-current is strong enough) the radiation losses may be considered to be negligible. The Newton's law of cooling then really remains valid even for large temperature differences. However, in most of the physics textbooks, the Newton's law of cooling is stated as follows:

"The rate of cooling of a body is proportional to its excess temperature over that of its surroundings, provided that this temperature difference is small."

This statement has created some misconceptions regarding the exact and precise scope of Newton's law of cooling. As pointed out by C.W. Hansel, when stated in this form 'Newton's law (of cooling) is not a law at all.' According to Hansel, all that is asserted in this statement is that a short enough part of the cooling curve is straight. However, this is necessarily true, whatever the shape of the curve.

In laboratory experiments, Newton's law of cooling is usually applied to the cooling of a calorimeter surrounded by a jacket. However, in such a case, conditions of forced convection are totally absent. Therefore, strictly speaking, five-fourths power law should be invoked for estimating the cooling of the calorimeter. However, for small temperature differences, the cooling correction obtained from the five-fourths power law would not be much different from the one obtained from the Newton's first or unit-power law. Therefore, for small-enough temperature differences, the error involved in using the Newton's unit-power law is negligible considering the accuracy with which we usually measure temperatures. This is perhaps the reason why the condition of small temperature difference continues to be attached as a string to the Newton's law of cooling although it remains valid even when the temperature differences are quite large.

To summarise, under conditions of natural convection, usually valid in the laboratory, one should, strictly speaking, apply five-fourths power law instead of the Newton's unit-power law. However, one reason why Newton's (cooling) law still continues to be used is that the error involved in the calculation of the cooling correction using this law is negligible for small temperature differences.

Another confusion arises from the statement that, for small temperature differences, Newton's law of cooling is derivable from the Stefan's fourth power law, according to which the heat-loss due to radiation is proportional to T_4-T_0^4, where T and T_0 are, respectively, the temperatures of the hot body and the surroundings.

$$R \alpha T^4 - R_0^4$$

$$\text{or } R \alpha (T - T_0)\left(T^3 + T^2 T_0 + T T_0^2 + T_0^3\right)$$

When the excess temperature of the body over that of the surroundings is small $(T \cong T_0)$, this reduces to

$$R \alpha\, 4T_0^3\,(T - T_0)$$

$$\text{or} \quad R \alpha (T - T_0)$$

This shows that the rate of heat-loss is approximately proportional to $T - T_0$; and is said to be the equivalent of the Newton's law of cooling. However, it may be emphasised that there is hardly any connection between the Stefan's fourth power law and the Newton's law of cooling; for, whereas the former refers to the cooling by radiation the latter refers to the cooling essentially by convection with radiation only playing an insignificant role. The scope of the two laws must, therefore, be very clearly understood. Otherwise, it would lead to unnecessary and unwarranted confusion that is still prevalent in most textbooks on Physics.

Factorial Factorized

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With how many zeroes does the factorial of 123456789 end? This question seems impossible to be answered, since the expansion of the factorial is beyond the capacity of even moderately-sized computers. Nevertheless, on some reflection, it is observed that each zero represents a factor of $10 = 2 \times 5$. Since 2 and 5 are prime numbers, the problem appears to be solvable, if we can find the multiplicity of the factor 2 and the multiplicity of the factor 5, and then take the minimum of the two multiplicities. On further reflection, it is observed that since 2 is less than 5, the multiplicity of the factor 2 should be more than the multiplicity of the factor 5. Thus, we need calculate only the latter multiplicity.

This brings us to the problem of factorizing the factorial of any positive integer n (>1) into prime factors. By the definition of factorial, every prime number $p \leq n$ appears in the factorization, and no prime number > n appears there. Thus, we are led to the problem of counting the multiplicity of any prime factor $p \leq n$, in the factorization of n!.

The factor p appears in the pth position, and thereafter, in the (2p)th, (3p)th, ...positions. This accounts for a multiplicity of $[n/p]$, where $[x]$ stands for the integral part of x. But this is not all. The factor p also appears in the (p^2)th, $(2p^2)$th, $(3p^2)$ th, ... positions. However, we have already counted p once in each of these positions. Thus, we have to count the same once more. This gives a multiplicity of $[n/p^2]$. Still, the factor p can appear in the (p^3)th, $(2p^3)$th, $(3p^3)$th, ... positions, and, as before, we get a multiplicity of $[n/p^3]$. If we continue in this way, we find that the total multiplicity of p is

$$[n/p] + [n/p^2] + [n/p^3] + \ldots$$

This is only a finite sum, since $[n/p^r] = 0$, if $p^r > n$. We thus have the fundamental lemma: Let n be any positive integer > 1, and let p be any prime number $\leq n$. Then the highest power of p, dividing n!, is given by

$$[n/p] + [n/p^2] + [n/p^3] + \ldots$$

Note: The required highest power can be calculated by the following procedure:

Divide n by p, keep the quotient and discard the remainder. Again divide the quotient by p, keep the second quotient and discard the remainder. Continue this process until zero-quotient is obtained. Then the sum of all quotients is the required highest power of p, dividing n!.

An Application: We recall that the symmetric group S_n, of degree n, is of order n!. If p is any prime number $\leq n$, then the order of any p-Sylow sub-group of S_n is

$$[n/p] + [n/p^2] + [n/p^3] + \ldots$$

Remark: For n=123456789 and p=5, the highest power of p, dividing n!, can be calculated by the above procedure. It works out to 30864192. Thus, the factorial of 123456789 ends with 30864192 zeroes. As another example, the factorial of 2370 ends with 589 zeroes.

The factorial of a number of the form 5^n, ends with $(5^n - 1) / 4$ zeroes. The factorial of a number of the form 10^n ends with $2^n . (5^n - 1) / 4$ zeroes. If N is any natural number with the unique factorization $p_1^{k_1}\ p_2^{k_2} \cdot\ .\ p_n^{k_n}$, where $p_1, p_2, \ldots, p_n$ are prime numbers, then the number of distinct factors of N is known to be $(k_1 + 1).(k_2 + 1). \ldots . (k_n + 1)$, including 1 and N. Using this formulae, the number of distinct factors of the factorial of any natural number can be calculated. This factorises the factorial.

An Insight into Multiplication

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The Primitive man started counting by recognizing similarities and dissimilarities of objects and grouped them. Later on with the concept of grouping the basic fundamental operations came into existence. In the antiques the clearer traces regarding the origin and development of these operations are not attributed to any particular time but it seems that through various civilizations the idea to combine the values and to increase it in magnitude was conceived and developed in different forms. The method of combining two numbers by adding one of them to itself as many times as the other states for multiplication came into force gradually, it took different shapes and the procedures adopted by the people in different parts of the world to multiply the members were also not same. In this paper we try to present the brief survey regarding the process of development of the operation multiplication and cover the important aspect of it from early civilization which may be useful for students to undertake some interesting activities in this topic.

In Egypt, during the early period the fundamental arithmetic operations was addition and all the calculations were based on this operation. During the Ahme's period the operations of multiplication and division were performed through duplication or successive doubling. To multiply 69 by 19, the procedure followed was based on addition where firstly 69 added to itself to obtain 138, then 138 added to itself to obtain 276, again adding 276 to itself to get 552 and finally 552 added to itself to get 1104 which is 16 times to 69. So the multiplication of 69 by 19 involves three different parts on the basis of subparts of 19 = 16+2+1 and the result comes as 1104 + 138 + 69 = 1311, which shows that Egyptians used only the operation addition at every step but they were aware about the word multiplications which was carried out on the basis of successive doubling not by repeated addition. Egyptians had used the commutative principle in multiplication and they were familiar to use the procedure to solve the problem related to fractions.

The fundamental arithmetic operations used by Babylonians were different to that of Egyptians. Babylonians introduced the concept of positional notation and easily developed the way to double, triple, quadruple or to get any other degree of tuples depending on their relative position in the representation of a number.

In Russia farmers had developed an unique algorithm to multiply the number, by using the notion, double one value and half other till one is obtained. Here we present some of the illustrations based on this notion with base value 2 and further generalize it for other base values.

Illustration 1: multiply 45 by 16
Using the concept double one value and half the other, we get
$90 \times 8 = 180 \times 4 = 360 \times 2 = 720 \times 1$

The algorithm devised by Russians can be generalized for any base number but due consideration to be given for the value of remainder if it is not perfectly divisible by base number because in the process of calculation we multiply first number and divide second number by the base value till we get remainder less than the base value at second place. So when the second number is not perfectly divisable by the base value at any stage we have to multiply the remainder with the first number of corresponding step and subsequently all such values to be added with the value obtained from the last step. Now, we illustrate it below.

Illustration 2: multiply 165 by 28
$165 \times 28 = 330 \times 14 = 660 \times 7$
1320×3 (remainder 1)
2640×1 (remainder)

So the answer is 2640 + 660 + 1320 = 4620, because 7 and 3 when divided by 2, leave remainder 1 and it is multiplied with corresponding first value of these numbers, i.e. 660 and 1320 respectively and then added to the value obtained from the last step.

Now we take base value 3 and use the notion, multiply one value by three and divide the other by three.

Illustration 3:
$463 \times 27 = 1389 \times 9 = 4167 \times 3 = 12501 \times 1 = 12501$

Illustration 4:
$267 \times 45 = 801 \times 15 = 2403 \times 5 = 7209 \times 1$ (remainder 2)

So the answer is, 7209 + 2(2403) = 12015, because 5 when divided by 3 leaves remainder 2 and it is multiplied with the first value of that step, i e. 2403 and then added to the last value.

Now we take base value 5 and use the notion, multiply one value by five and divide the other by five.

Illustration 5: 623×85
3115×17
15575×3 (remainder 2)

So the answer is $15575 \times 3 + 3115 \times 2 = 46725 + 6230 = 52955$ because 17 when divided by 5 leaves remainder 2 which is multiplied with 3115 and finally added to the last value.

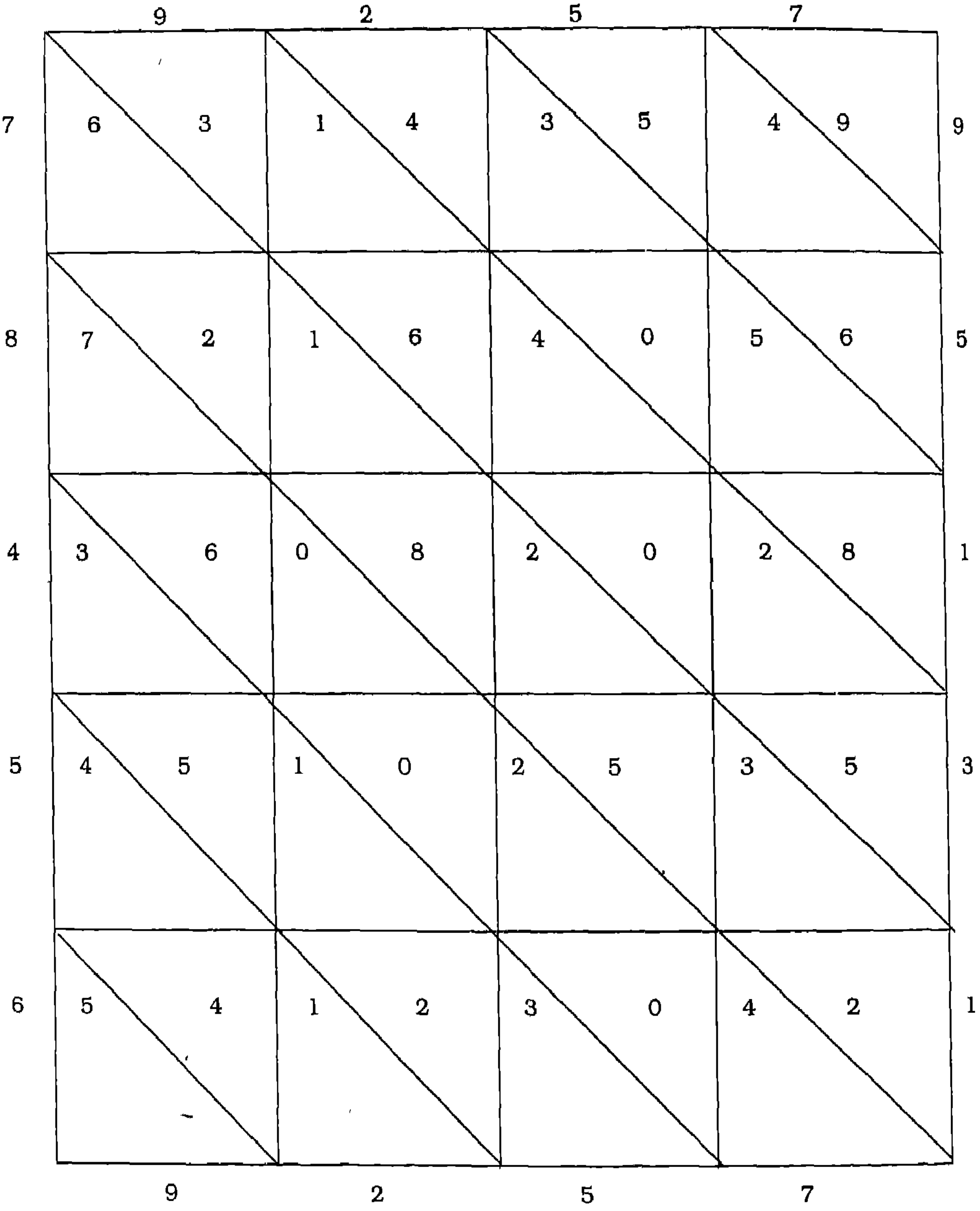
Illustration 6: Here we take base value 7 and use the notion multiply one value by 7 and divide other by 7
$68 \times 343 = 476 \times 49 = 3332 \times 7 = 23324 \times 1 = 23324$.

During the ancient period Indians also devised their own way to multiply the number and this method was known by the names as gelosia multiplication, lattice multiplication or cell or grating or quadrilateral multiplication. They used small blackboards with white paints or board covered with sand or flour to carry out the multiplication. In gelosia multiplication of two different systems are followed to multiply the numbers on the basis of the arrangements of numbers in the board/pattern. Here we illustrate these patterns with explanation of the steps involved in the process.

Illustration 7: 9257 × 65487
9257 × 65487 = 606213159

Explanation

Step1: see the multiplicand and

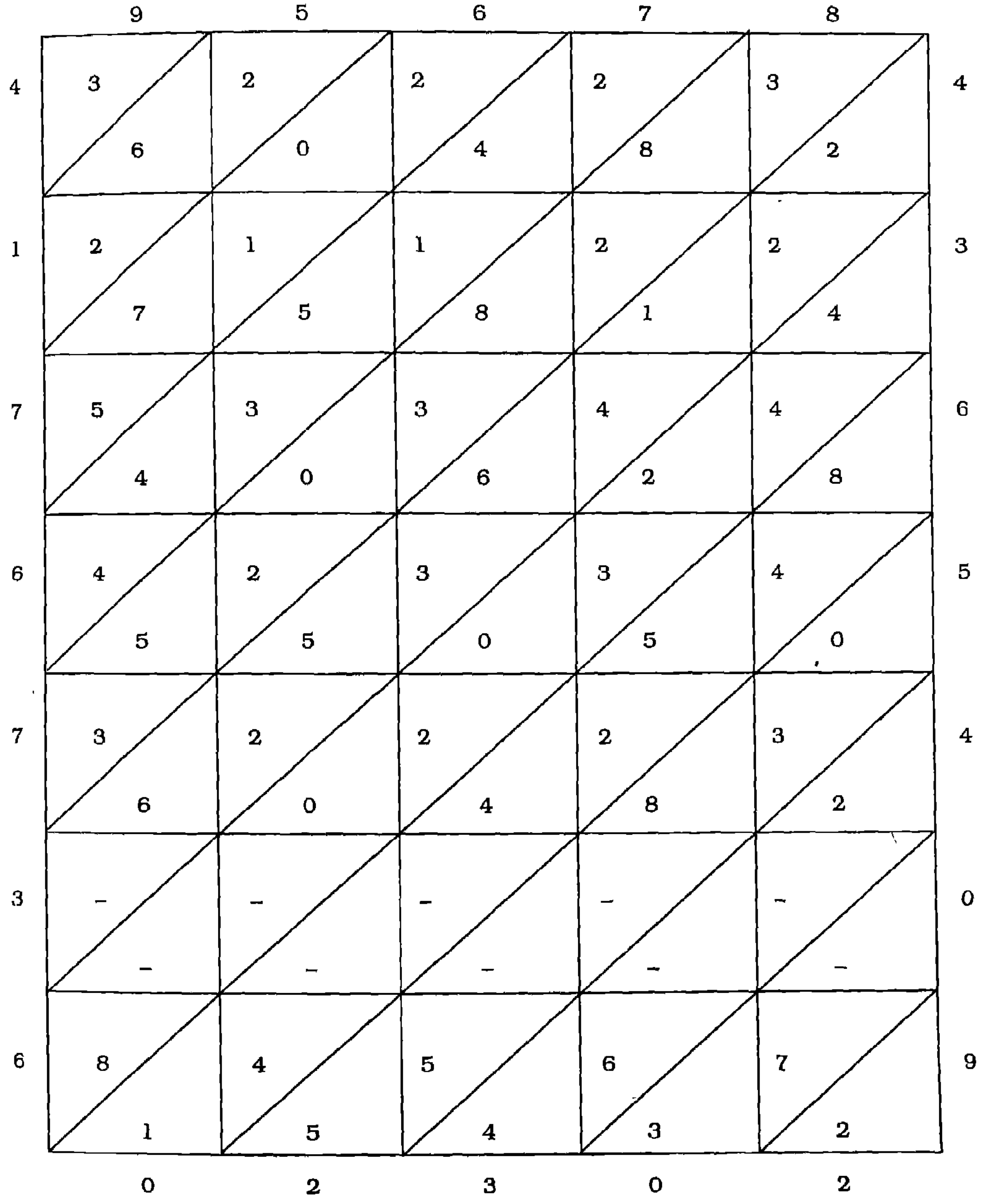


	9	2	5	7	
7	6 3	1 4	3 5	4 9	9
8	7 2	1 6	4 0	5 6	5
4	3 6	0 8	2 0	2 8	1
5	4 5	1 0	2 5	3 5	3
6	5 4	1 2	3 0	4 2	1
	9	2	5	7	

count the digits in it, draw the columns in block equal to the number of digits.

Step 2: see the multiplier and count the digit in it Draw rows in block equal to the number of digits.

Step 3: place the digits of multiplicand from left to right in



	9	5	6	7	8	
4	3/6	2/0	2/4	2/8	3/2	4
1	2/7	1/5	1/8	2/1	2/4	3
7	5/4	3/0	3/6	4/2	4/8	6
6	4/5	2/5	3/0	3/5	4/0	5
7	3/6	2/0	2/4	2/8	3/2	4
3	–/–	–/–	–/–	–/–	–/–	0
6	8/1	4/5	5/4	6/3	7/2	9
	0	2	3	0	2	

the same order as in the given number.

Step 4: place the digits of multiplier from below to above in the left side of the block as given in Illustration 7.

Step 5 . join the diagonals as in Illustration 7.

Step 6: multiply the corresponding digits and put the value in the block as shown in Illustration 7.

Step 7: add the digits of corresponding diagonals taking the carry over value to the next diagonal and write the answer as given in Illustration 7.

Illustration 8: 95678 × 4365409

Explanation

Step 1: see the multiplicand, count the digits in it and draw the columns in block equal to the number of digits.

Step 2: see the multiplier, count the digits in it and draw the rows in block equal to the number of digits.

Step 3: place the digits of multiplicand from left to right.

Step 4: place the digits of multiplier from above to below in the right side of the block.

Step 5: join the diagonals.

Step 6: multiply the corresponding digits and put the values in the way as shown in illustration 8, further add the digits in corresponding diagonals and get the value.

95678 × 4365409 = 417673602302

Lilavati, a well-known treatise of Bhaskaracharya in Mathematics gives another way of multiplication in the chapter *Atha Gurane Karansutram Sardha-Vritidwayam.* Bhaskaracharya explains the process of multiplication with the notion *Ankanam Bamto Gati* as illustrated below for 135 × 12.

(i) 135 × 12 first multiply the extreme left digit of the multiplicand to multiplier and put the values as

12 35 (12 × 1 = 12)

(ii) multiply the second digit from left to multiplier and put the value with carry over

15 65

(12 × 3 = 36 carry over 3, 12 + 3 = 15)

(iii) multiply the third digit to multiplier and put the value with carry over

16 20

(12 × 5 = 60 carry over 6+6 = 12, carry over 1; then 15 + 1 = 16)

Illustration 9: 2146 × 12

(i) 24146 : (12 × 2 = 24)

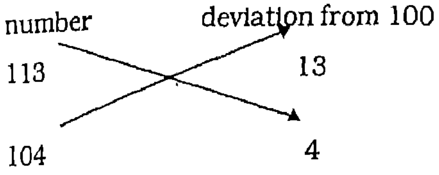
(ii) 25246 : (12 ×1 = 12 carry over 1; 24 + 1 = 25)

(iii) 25686 : (12 × 4 = 48, carry over 4; 2+4 = 6; 252 + 4 = 256)

(iv) 25752 : (12 × 6 = 72; carry over 7; 8 + 7 = 15; 2568 + 7 = 2575)

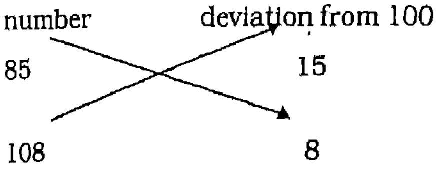
Indian mathematicians Sridhar and Brahmgupta described the four methods of multiplication whereas Mahavira-charya had shown the five different methods of multiplication. In ancient period the some other methods were also followed in India to multiply the numbers easily and quickly. We illustrate these methods here which are based on the deviations and positional values.

Illustration 10: 113 ×104



(113 + 4) or (104 + 13) / 13 × 4
= 11752

Illustration 11: 85 × 108

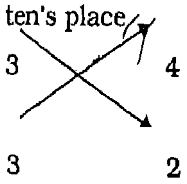


(85 + 8) or (108 – 15)/15 × 8
93/120 = 92/20 (100 – 20 = 80 with borrowing value 1)

Illustration 12: 534 × 132

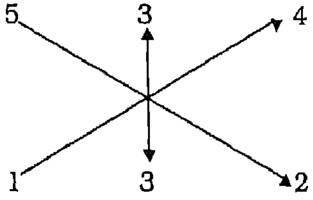
5 3 4
1 3 2

unit place 4 × 2 = 8; digit at unit place is 8.



= 6 + 12 = 18

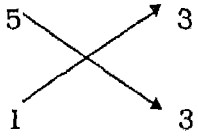
digit at tens place 8, carry over 1
hundred's place



= 5 × 2 + 4 × 1 + 3 × 3 = 23

so digit hundred's place 4 with carry over 2

thousand's place



= 15 + 3 = 18

so the digit at thousand's place 0 as 18+2 = 20 with carry over 2 ten thousand's place 5 × 1 = 5

digit at ten thousand's place 5+2 (carry over) = 7

so answer is 70488

The specific methods to multiply the numbers by using deviations is more interesting where we use the basic formula related to

$$(x+\alpha_1)(x+\alpha_2)(x+\alpha_3)\,..(x+\alpha_n)$$

in which x is the number from where we take the deviations and α_1, α_2 ...α_n are the actual deviations. The calculation will be based on the following step.

$$x^n/x^{n-1}\ \ \Sigma\alpha_1/x^{n-2}\ \Sigma\alpha_1\alpha_2/x^{n-3}$$

$$\Sigma\alpha_1\alpha_2\alpha_3/\ldots\ /\alpha_1\alpha_2\alpha_3\ldots\alpha_n$$

To demonstrate this method

illustrations are given below with different bases.

Illustration 13: $976 \times 985 \times 1005 \times 1017$

number	deviations from 100	
976	–24	α_1
985	–15	α_2
1005	5	α_3
1017	17	α_4

$$\Sigma\alpha_1 = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = (-24) + (-15) + 5 + 17 = -17$$

$$\Sigma\alpha_1\alpha_2 = \alpha_1\alpha_2 + \alpha_1\alpha_3 + \alpha_1\alpha_4 + \alpha_2\alpha_3 + \alpha_2\alpha_4 + \alpha_3\alpha_4$$

$$= (-24)(-15) + (-24)(5) + (-24)(17) + (-15)(5) + (-15)(17) + 5(17) = -413$$

$$\Sigma\alpha_1\alpha_2\alpha_3 = \alpha_1\alpha_2\alpha_3 + \alpha_1\alpha_2\alpha_4 + \alpha_2\alpha_3\alpha_4 + \alpha_3\alpha_4\,\alpha_1$$

$$= (-24)(-15)(5) + (-24)(-15)(17) + (-15)(5)(17) + 5(17)(-24) = 4605$$

$$\alpha_1\alpha_2\alpha_3\alpha_4 = (-24)(-15)(5)(17) = 30600$$

so the value is

$1^4/1^3(-17)/1^2(-413)/1(4605)/30600$

$1/_1{-983}/-413/4605/30600.$

$[(1000 - 17) = 983]$

983/–413/4605/30600.

$983/_1{-587}/4605/30600$

$[1000 - 413 = 587]$

982 587 /4605/30600

(each block of three digits so four and thirty are carry over from second and third block)

982 591 605 / 30600

982 591 635 600.

= 982591635600.

Illustration 14: $46 \times 48 \times 33 \times 39$

number	deviations from 40
46	$6(\alpha_1)$
48	$8\ (\alpha_2)$
33	$-7(\alpha_3)$
39	$-1(\alpha_4)$

$$\Sigma\alpha_1 = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 6 + 8 + (-7) + (-1) = 6$$

$$\Sigma\alpha_1\alpha_2 = \alpha_1\alpha_2 + \alpha_1\alpha_3 + \alpha_1\alpha_4 + \alpha_2\alpha_3 + \alpha_2\alpha_4 + \alpha_3\alpha_4$$

$$= 6(8) + 6(-7) + 6(-1) + 8(-7) + 8(-1) + (-7)$$

$$= 48 - 42 - 6 - 568 + 7 = -57$$

$$\Sigma\alpha_1\alpha_2\alpha_3 = \alpha_1\alpha_2\alpha_3 + \alpha_1\alpha_2\alpha_4 + \alpha_3\alpha_4\alpha_1$$

$$= 6(8)(-7) + 6(8)(-1) + 8(-7)(-1) + (-7)(-1)$$

$$= -48 \times 7 - 48 + 56 + 42$$

$$= -336 - 48 + 56 + 42 = -286$$

$$\alpha_1\alpha_2\alpha_3\alpha_4 = 6(8)(-7)(-1) = 48 \times 7 = 336$$

so $46 \times 48 \times 33 \times 39$

$$= 4^4/4^3\Sigma\alpha_1/4^2\Sigma\alpha_1\alpha_2/4$$

$$\Sigma\alpha_1\alpha_2\alpha_3 / \alpha_1\alpha_2\alpha_3\alpha_4$$

$$= 256/64(6)/16(-57)/4(-286)/336$$

$$= 256/384/-912/-114/336.$$

(one digit block, so 38 and 33 are carry over in second and fifth block)

= 2944/-912/-111/6

(-111, carry over value in third block)

= 2944/-1024/-1/6

(-102 as carry over value in second block)

= $2944/\bar{3}/\bar{1}/6$

= 2841696

($\bar{1} = 10 - 1 = 9$, $\bar{3} = 9 - 3$, with borrowing value)

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Integrating Critical Thinking Skills in the Classroom

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Introduction

What is Critical Thinking? The term 'Critical Thinking' is intimidating! It is often perceived as an esoteric exercise of the mind, an intangible pursuit, reserved for the likes of Socrates, Aristotle and Einstein. However, for us, critical thinking is best defined simply as "what you generate, you know." Only those who can reconceptualize content for themselves have truly learned it.

Critical Thinking

The term critical thinking is broadly used in educational circles. It is often associated with "higher order" thinking. As often as not critical thinking is described as a specific set of skills. When we use the term critical thinking, the context is from the Critical Thinking Movement This form of critical thinking is best described in the book by Richard Paul, *Critical Thinking, how to prepare students for a rapidly changing world*, 2001, The Foundation for Critical Thinking, Santa Rosa, CA, the centre for Critical Thinking located at Sonoma State University provides basic information on critical thinking as well as useful resources and references, and an archive of on-going discussions. Our use of the term hypothesis is neither unique to scientists not critical thinkers, but it is helpful to understand its relationship to other elements of critical thinking. Critical thinking involves several elements which include the following:

- *Purpose for Thinking:* goal, objective
- *Question at Issue:* the problem
- *Concepts.* theories, definitions, axioms, laws, principles, models
- *Assumptions:* presuppositions, taken for granted
- *Information:* data, facts, observations, experiences
- *Interpretations and Inferences:* conclusions, solutions
- *Points of View:* frame of reference, perspective, orientation
- *Consequences and Implications*

Hypotheses fall into the category of concepts. Concepts are mental constructs which may or may not be consistent with the real world. Students bring misconceptions into the classroom all the time and it is our job to challenge their thinking and provide an experiential base for reconstructing how they know their world that is consistent with the laws of the natural world. The consequence of student notions is the hypothesis, the model of how they think things work. It provides us the opportunity for them to learn to think scientifically, think critically by testing their models on our terms (the laboratory).

In addition to these elements of reason, critical thinkers subject their thinking to universal standards such as clear, precise, relevant, accurate, deep, significant, consistent, broad, logical, realistic, rational, and fair. The goal, of course, is to teach such standards to our students so that they acquire the traits of critical thinkers which include intellectual independence, empathy, humility, courage, integrity, perseverance, curiosity, civility, responsibility, and faith in reason. To us, this is what education should be about.

Critical Thinking is not just one more thing you tack on to your Science curriculum. It is the fundamental approach you use to address that curriculum. Critical thinking is disciplined, self-directed thinking. It requires thinking about your thinking while you are thinking in order to make your thinking more clear, more accurate and more defensible. Indeed, scientists do this already every time they use the scientific method. They ask questions, gather and assess relevant information, come to well-reasoned conclusions/solutions, and they communicate effectively when they write up results.

The *Traits* of a good scientist are the traits of a well-cultivated critical thinker. The ultimate goal of using critical thinking instruction in a science course is to get students to think like a scientist thinks.

Getting Started in Critical Thinking

Early in my teaching career, I happened upon a magazine in the teachers lounge entitled *Critical Thinking: Shaping the Mind of the 21st Century*. The first article I encountered addressed the fundamental need for more critical thinking in the classroom. The issues raised by the article were the very same issues that we try to deal in our own classrooms. One must learn how to redesign the existing lessons in order to incorporate critical thinking strategies. You will have to plan effectively on how to.

- *Cover content* in such a way that students grasp and retain more
- *Engage* the students in thinking deeply about the content
- Motivate students to take more *responsibility* for their own learning
- Teach *students to read* for themselves, *actively and analytically*
- Focus on fundamental and powerful concepts with high generalizability as tools for the solutions to *real-world problems*
- Regularly *question* students *Socratically* distinguishing between *categories of questions*
- Use *concrete examples*
- Illustrate *abstract concepts*
- Spell out explicitly the *intellectual standards* used in *grading*.

Engage the students in thinking deeply about the content by showing students that there is a logic to things. It is easier to understand some concept if you get the logic behind it. For example, there are two ways to teach a topic: (i) the teacher lectures about the content, perhaps demonstrates, students memorize the facts and then are tested. (ii) Opening the topic with questions to explore what the students know and posing problems to be solved. The direct instruction is in how to analyze, evaluate or synthesize and then allow the students to put the two together. To encourage students to reflect on the process further help students practice the elements of reasoning, assess using the intellectual standards. The key concept is that to understand an idea, you must talk the idea, write the idea, think the ideas into your system. It becomes second nature.

Teach students to read for themselves, actively and analytically. This may be attempted as given below. We read a portion of the text aloud, stopping at the end of each sentence. We ask a different student (using cards to assure randomness) to rephrase what one student just read. If they cannot, we then break the sentence down, and determine what it is that the student does not understand. We then find out what that part means, even if we have to use a dictionary or ask someone else. "I do not know", is not an acceptable answer, since the student has to understand before we move on. Slowly, we rebuild the sentence until the student can put the whole thing into this or her own words.

This is absolutely painstaking at first, but eventually we can trust students to read and analyze anything they are given (including graduate level books). They learn to engage in an inner dialogue with the author, and so actually understand deeply. They realize the way in which reading means entering into a point of view other than their own, the point of view of the writer. They learn to actively look for assumptions, key concepts and ideas, reasons and justifications, supporting examples, parallel experiences, implications and consequences, and any other structural features of the written text, to interpret and assess it accurately and fairly.

As we learn to understand as we read, learning is facilitated. Eyes are not just travelling over a page. Identify questions you would like to ask the author, identify the implications or consequences of the author's position, identify assumptions author is making, what the author is leaving out? Model all this for your students by reading out loud and rephrasing, raise questions that come to mind, elaborate with examples of your own. Half page thing with summaries on one side, questions on the other applies to listening, too! Ask them frequently to rephrase what is being said. We can also have students pair up and alternate reading a paragraph aloud, back and forth, with the students responding to each other about the quality of their rephrasing, checking for accuracy in restaging, providing elaboration and examples. We can sometimes take a sample of writing and ask students to summarize it in writing, saying no more and no less, giving exactly the emphasis it gave and being true to the tone. This takes a lot of practice, yet until we understand clearly what was said, how can we agree or disagree with the content? We also need to link to an experience in real life.

Using 3"x5" note cards with their names on it, we can call randomly on students to read aloud from a piece of writing, one sentence at a time. Then, they can rephrase the sentence using their own words. Sometimes we have the individual rephrase the sentence he read, and sometimes we have someone else do it. They never know whether they will be called on and this keeps them listening and engaged. After we have picked through the passage a piece at a time, we have several students rephrase the entire work. It gets clearer and more succinct each time through. Students see how much easier it is to understand text when it is rephrased (and begin to realize a reduced need for plagiarism). This exercise also introduced the concept of perserverance when confronted with difficult material, something we demand on a daily basis. Finally, we can have a writing assignment that follows up on the quote. Students apply the quote to their own life by picking out a portion that 'resonates' with them and they explain that to us. They must be very clear and show us how the situation links with the quote. With this, we can see their writing abilities right off the bat, we can see how well they make and defend connections they perceive, and we have homework right away so that they realize that we mean business. And, in a world where many students are intimidated with science (and come to class with a closed mind), this is a non-standard approach which, hopefully, lets them have a more positive, curious attitude about the class.

Intellectual Standards : Five Aspects Used to Assess Results

'Why Critical Thinking' has three sections called : The Problem, 'a Definition, and the Result. The Result section is what we refer to a 'The Five Aspects.' It goes as, "A well-cultivated critical thinker: raises vital questions .." We use these five aspects to evaluate the quality of everything! We start off with reading a persuasive speech about punishments for drunk driving. Then, the students write a letter to the author using the five aspects as a guide. For example, "Dear author, I read your speech about drunk driving. I can tell that you raised a vital question and it is—What can we do about drunk driving?" I see that you gathered and assessed relevant information because you said "...". They must write down what they identify in the speech as relevant information or, if the material is not there, they must say, "You did not gather and assess relevant information." May I suggest you do the following, and give some direction to the author. This let us see where their weaknesses are that we need to focus on. We chose drunk driving to make obvious points and, again, we don't want to make this too complex by using science content, yet, or having them try to assess themselves before they really understand the rubric. We are confident that, once they are clear about what is expected, having first been the assessor, they will know better how to approach a situation when it is their turn to turn out a product (and know what pitfalls to void).

The other key component to our approach is that we have an all-or-none grading policy with re-do's as the only option Either you do *Really Good* work the first time and get 100 per cent or else you take a zero and do the work over and over until it meets the requirements. W are very selective as to what we accept because we heard the quote, "The worst paper that you accept becomes your highest standard." After a time, laziness prevails and students do a nice job only the first time. We hope to corrupt their brain with this tendency permanently. We point out that you do not get paid 65 pe cent for a 65 per cent effort at work, you just get fired. There are plenty of people waiting in line for your job! So get used to doing your best all the time now. The classroom is the place to practice.

Critical Thinking in the Classroom

Three things must come together in the classroom: One, students must reason (a bridge from their present thinking to the new thinking you are looking for); Two, students must reason about the context (the new way you want them to think); and Three, there must be a 'hook' (recognition of students' present thinking) so that students will be willing to do the first two. In Richard Paul's words, "When your students are learning well, they are employing the logic of their own thinking as a tool in learning. They are reasoning their way into the logic of a somewhat new system, a somewhat new way of thinking, so you need to give them assignments and design activities that help them to bridge between these two, their old thinking and the new." One has to restructure classroom transactions based on these strategies.

As an example let us see one of the teachers lesson redesign about bacteria. Instead of the didactic approach he had previously used, he 'hooked' the students interest by posing shocking questions that addressed the major concepts he wished to cover such as:

- "Is it better to kiss your girl-friend on the lips or lick her armpit?" (pathogenicity)
- "Why don't you have to plow your way through road kill to get to school?" (decomposition)
- "Where does your breakfast come from?" (nitrogen cycle/primary producers)
- "What do a bottle of wine, cheese and a compost heap have in common?" (fermentation)
- "Bacteria live where?!" (digestion and symbiosis)
- "What do diabetics and bacteria have in common?" (genetic engineering)

He had put the students into six groups and assigned each group one of these questions. The group researched their question and presented the answer to the rest of the class. He also taught the students how to reason by using the *elements of reason* as a structure for examining the content. He had the students go through each of the elements, determining how that element applied to the situation they had been given. Since the questions they had been asked had already piqued their interest, they were engaged enough to go to some effort to find out the answers. Because they had learned a process for reasoning, they were able to analyze the questions just as a scientist would, and to determine a conclusion based on information, rather than just their first impression They discovered it was better to lick their girlfriend's armpit, and in the process retained the reason why

In Summary

Over the years, one has to refine this type of embryonic notion to create a more *complete approach* that which would more suit. We found that we, like the students, do much better when we personally generate the techniques. This clearly is not the only way to do critical thinking, it is simply one of our approaches.

Critical thinking has become an integral part of our teaching. We infuse it on three levels: to plan daily lessons and course-wise objectives, by modeling good critical thinking practices in front of students and by creating activities that foster critical thinking in the students themselves. We make it become second nature.

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The Principle and the Method of Finding out the Cube Root of Any Number

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The two methods usually employed to find the cube root of a number are, (i) the method of factorisation and (ii) the division method. However, it is the method of factorisation that generally finds a place in the school mathematics to obtain the cube root of a number. It may be pointed that this method is convenient to find cube root of the numbers that are a perfect cubes. Here an attempt has been made to explain the method to find the cube root of any number by the method of division. The advantage of this method over the method of factorisation is that it is possible to find the cube root of any number up to the desired decimal places.

Section (A)

The principle of finding out cube root of a number is based on the following known identities and the pattern:

$$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

$$= a^3 + (3a^2 + 3ab + b^2)\,b \qquad \text{(i)}$$

and

$$(a + b + c)^3 = (a + b)^3 + 3(a + b)^2c + 3(a + b)c^2 + c^3$$

$$= a^3 + (3a^2 + 3ab + b^2)b + [3(a + b)^2 + 3(a + b)\,c + c^2]c \qquad \text{(ii)}$$

also

$$(a + b + c + d)^3 = (a + b + c)^3 + 3(a + b + c)^2d + 3.\,(a + b + c).d^2 + d^3$$

$$= a^3 + (3a^2 + 3ab + b^2)b + [3(a + b)^2 + 3(a+b)c + c^2]\,c + [3\,(a + b + c)^2 + 3(a + b + c)\,d + d^2].\,d \qquad \text{(iii)}$$

on the above pattern, we can write

$$(a + b + c + d)^3 = a^3 + (3a^2 + 3ab + b^2)b + [3(a+b)^2 + 3(a+b).\,c + c^2]c + [3(a + b + c)^2 + 3\,(a + b + c)\,d + d^2]d + [3(a + b + c + d)^2 + 3\,(a + b + c + d)\,e + e^2]e \qquad \text{(iv)}$$

We see that the identities (i), (ii), (iii) and (iv) have a pattern. Therefore with the help of this pattern we can write cube of any expression.

Section (B)

We can suppose a number in the form of $(a + b)^3$ or $(a + b + c)^3$ or $(a + b + c + d)^3$ etc., and then we find out the value of (a + b), (a + b + c) or (a + b + c + d) as the case be. Thus, the cube root of that number is determined.

In (a + b), a is tens and b is ones.

or if a is ones, then b will be first digit after decimal point.

or if a is first digit after decimal point, then b will be second.

In (a + b + c), a is hundreds, b is tens and c is ones.

or if a is tens, then b is ones and c is first digit after decimal point
or if a is ones, then b and c are first and second digits after decimal point, etc.

Section (C)

We know that $1^3 = 1$, $2^3 = 8$, $3^3 = 27$, $4^3 = 64$ and $5^3 = 125$ ...

and $10^3 = 1000$, $20^3 = 8000$, $30^3 = 27000$, $40^3 = 64000$
and $100^3 = 1000000$, $200^3 = 8000000$, $300^3 = 27000000$, $400^3 = 64000000$

It shows that cube root of a number having 1, 2 or 3 digits will be of one digit.

Cube root of a number, having 4 to 6 digits, will be of two digits

Cube root of a number, having 7 to 9 digits, will be of three digits.

Section (D)

If a number is multiplied by 1000, then its cube root will be increased by ten times.

If a number is multiplied by 1000000, then its cube root will be increased by hundred times.

If a number is multiplied by 10^9, then its cube root will be increased by thousand times. And so on.

With the help of this property, we can find out cube root of small numbers. This property may also be helpful in finding cube root up to desired number of decimal places.

Section (E)

As it has been already said Section (B) above that a number can be written in the form of $(a + b)^3$, $(a + b + c)^3$ or $(a + b + c + d)^3$, etc.

i.e. in the form of

$$a^3 + (3a^2 + 3ab + b^2)\,b \qquad \text{(I)}$$

or $$a^3 + (3a^2 + 3ab + b^2)\,b + [3(a+b)^2 + 3\,(a+b).c + c^2]c \qquad \text{(II)}$$

or $$a^3 + (3a^2 + 3ab + b^2)b + [3(a+b)^2 + 3\,(a + b).c + c^2]c + [3.(a + b + c)^2 + 3\,(a + b + c).d + d^2].d \qquad \text{(III)}$$

Procedure of Finding Cube Root

(I) We can easily find the value of a as in Section (C). We subtract a^3 from expression (I) above.

The remainder is $(3a^2 + 3ab + b^2)b$

(II) Now putting the value of a in the expression $(3a^2 + 3ab + b^2)$, we try to find out the value of b by division method through approximation.

Now value of a and b are known.

(III) We put the values of a and b in expression $[3\,(a + b)^2 + 3(a+b).c + c^2]$ and we try to find out value of c by division method through approximation.

This process can be continued for finding values of d and e etc.

Solved Examples

Example 1

To find out the cube root of 3375.

Method

(i) We know $10^3 = 1000$, $1000 < 3375$ and $20^3 = 8000$, $8000 > 3375$

It shows that the cube root of 3375 lies between $3.10^2 + 3.10.5 + 5^2$ 10 and 20, therefore $a = 10$ and $a^3 = 1000 = 475$

$$\begin{array}{r|l} & 10 + 5 \\ \hline 10^2 & 3375 \\ & 1000 \\ \hline & 2375 \\ & 2375 \\ \hline & 0 \end{array}$$

(ii) Now subtracting 1000 ($10^2 \times 10$) from 3375 remainder is 2375 ∴ Cube root of 3375 = 10 + 5 = 15

(iii) To find the value of b we put a = 10 in expression $3a^2 + 3ab + b^2$. We get
$= 3.10^2 + 3.10$ app.
= 330 app.

(iv) If we divide 2375 by 330 we get quotient = 7 app.
i.e b = 7. Putting a = 10 and b = 7 in expression $(3a^2 + 3ab + b^2)$ b, we get
$(3.10^2 + 3.10.7 + 7^2)7$
$= (300 + 210 + 49)7 = 459 \times 7$
= 3913

(v) We see that 3913 > 2375
So we put a = 10 and b = 5 in the expression
We get $(3.10^2 + 3.10.5 + 25)5$
$= (300 + 150 + 25)5 = 475 \times 5 = 2375$
Therefore b = 5 is the right value.
∴ Cube root of 3375 = 15.

Example 2

Find cube root of 54321.

(i) Making groups of three from RHS, we see that 54 is left whose cube root lies between 30 and 40.

So a = 30 and $a^3 = 2700$

Subtracting 27000 from 54321, remainder is 27321.

(ii) Putting a = 30 in exp. $3a^2 + 3ab + b^2$
Value of expression $= 3.30^2 + 3.30$
$= 2700 + 90$
= 2790 app.

Dividing 27321 by 2790,
we see that quotient may be 8 or 9
Putting a = 30 and b = 8 in the expression
$(3a^2 + 3ab + b^2)b$, we get
(3.302 + 3 30.8 + 82)8
= (2700 + 720 + 64)8
= 27872 > 27321
Therefore b = 7 is the correct value
Put b = 7 in the expression
We get $(3.30^2 + 3.30\ 7 + 7^2)7$
$= 3379 \times 7$
= 23653

Subtracting 23653
from 27321,
remainder is 3668

```
         30 + 7 +.8
     30² │ 54321
         │ 27000
         ├────────
         │ 27321
         │ 23653
         ├────────
         │ 3668000
         │ 3357152
         ├────────
         │  310848
```

$$\left(3.30^2 + 3.30.7 + 7^2\right)$$

$$= 3379$$

$$\left[\begin{array}{l}3(300 + 70)^2 \\ + 3(300 + 70)(8) + \left(8^2\right)\end{array}\right]$$

$$= 419644$$

(iii) We increase three zeros in remainder 3668 to find out cube root in decimal.

Here a, and b will increase 10 times.

i.e. a = 300 and b = 70

Put a = 300 and b = 70 in expression $3(a+b)^2 + 3(a + b)c + c2$, We get 3(300 + 70)2 + 3(300 + 70)

$= 3.(370)^2 + 3(370)$

= 410700 + 1110

= 411810

Dividing 3668000 by 411810,

Quotient is 8 or 9

Putting a = 300, b = 70 and c = 8 in the expression [3(a + b)2 + 3 (a + b)c + c^2]c

We get $[3(300 + 70)^2 + 39300 + 70)$ $(8) + (8^2)](8)$

= (410700) + 8880 + 64)(8)

$= 419644 \times 8$

= 335715 < 3668000

Therefore c = 8 is correct value

∴ Cube root of 54321 = 37.8

Note: If we want to find out cube root up to 2 decimal places, we will have to continue the process increasing three zeros in the remainder. Now a, b, c will increase 100 times i.e. a = 3000, b = 700 and c = 80.

Example 3

Find cube root of 15.

$$\begin{array}{r|l} & \overline{\;2.46\;} \\ 2^2 & 15 \\ & .8 \\ \hline & 7000 \\ & 5824 \\ \hline & 1176000 \\ & 1062936 \\ \hline & 113064 \end{array}$$

Cube root of 15 = 2.46

(i) Cube root of 15 lies between 2 and 3 therefore a = 2 and a^3 = 8

(ii) Subtracting 8 from 15, remainder is 7. We increase 3 zeroes to find first decimal value. Now a will become 10 times i.e. a = 20

$[3.20^2 + 3.20.4 + 16]$
$= 1456$

(iii) Putting a = 20 in the exp. $3a^2 + 3ab + b^2$, we get $3.(20)^2 + 3.(20)$ = 1260 approx.

$3(200 + 40)^2 + 3(200 + 40)6 + 6^2$
$= 177156$

Now dividing 7000 by 1260, we get quotient = 5

Therefore b = 5.

(iv) If we put a = 20 and b = 5 in the expression $[3a^2 + 3ab + b^2]b$,
we get $[3.(20)^2 + 3 \times 20 \times 5 + (5)^2]^5$
$= (1200 + 300 + 25)5$
$= 1525 \times 5$
$= 7625$,
which is greater than 7000
Therefore the correct value of b = 4

Putting a = 20 and b = 4 in expression, we get
$[3.(20)^2 + 3 \times 20 \times 4 + (4)^2]4$
$= 5824$

Subtracting 5824 from 7000, remainder is 1176.

(v) We again increase 3 zeroes in the remainder, now a = 20 and b = 40

Putting value of a and b in exp $3(a + b)^2 + 3(a + b)c + c^2$,. we get
$3(200 + 40)^2 + 3(200 + 40)c + c^2$
$= 3 \times 57600 + 720$ approx.
$= 172800 + 720$ approx.
$= 173520$ approx.

Dividing 117600 by 173520, we get value of c = 6.

Putting values of a, b, c in the expression $[3(a + b)^2 + 3(a + b)c + c^2]c$, we get
$[3(200 + 40)^2 + 3(200 + 40)\,6 + 36]$
$= 3 \times 57600 + 4320 + 36]6$
$= 1771560 \times 6$
$= 1062936$

Subtracting 1062936 from 1176000, remainder is 113064.

Therefore cube root of 15 = 2.46

Example 4

Find cube root of 5 up to two decimal places.

(i) Cube root of 5 lies between 1 + 2
Therefore a = 1 and a^3 = 1
Subtracting 1 from 5, remaining is 4.
Increase 3 zeroes to get cube root up to one decimal place. Here a = 10.
Putting a = 10 in expression $(3a^2 + 3ab + b^2)$, we get $3.10^2 + 3.10$ approx
= 330 approx.

(ii) Dividing 4000 by 330, we get b = 9 b = 9 is app. value, putting values of a & b in expression $(3a^2 + 3ab + b^2)$, we get

$[3(10)2 + 3.10.9 + 81]9$

$= (300 + 270 + 81)9$

$= 651 \times 9$

= 5859 which is far greater than 4000.

Therefore putting b = 7 in the expression, we get

$(300 + 210 + 49)\,7$

$= 559 \times 7$

$= 3913 < 4000$

Therefore value of b = 7

	1 709
1	5
	1
$3\,10^2 + 3.10.7 + 49 = 559$	4000
	3913
3(170)2 + 3.(170) 0 +0 = 87210	87000
	00000
8715981	87000000
	78443829
	8556171

Cube root of 5 = 1. 709

(iii) Subtracting 3913 from 4000, remainder is 87

Increasing 3 zeros in remainder, it becomes 87000.

Now value of a = 100 and b = 70

Putting values of a and b in expression $3(a + b)^2 + 3\,(a + b)c + c^2$, we get $3\,(100 + 70)^2 + 3(100 + 70)$ approx.

$= 3 \times 28900 + 510$

$= 87210 > 87000$

It shows that the value of c is less than 1. ie value of c = 0

Putting value of a, b, c in expression, we see that expression becomes zero subtracting 0 from 8700 remainder is 87000.

(iv) As we have already seen that 87210 is slightly greater than 8700, therefore now the value of d may, be 9.

Increasing 3 zeros in remainder it becomes 87000000.

Now putting a = 1000, b = 700, c = 00, d = 9 in the expression.

$[3\,(a + b + c)^2 + 3\,(a + b + c)d + d^2]d$, we get

$[3(1000 + 700 + 00)^2 + 3\,(1000 + 700 + 00)\,(9) + (9)^2]9$

$= [3 \times (1700)^2 + 3 \times 1700 \times 9 + 81]9$

$= [3 \times 2890000 + 5100 \times 9 + 81]9$

$= [8670000 + 45900 + 81]9$

$= 78443829$

Therefore cube root of 5 = 1.709

Note: If the students become familiar with this process, it will be easier to them.

Study of Attitude of +2 Students Towards Physics Laboratory Work

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Laboratory work plays a central role in science education and more importantly in Physics Education. In fact, all new science curricula in schools emphasize on open-ended experiments so as to help develop a better and meaningful understanding of physics concepts. Though students are usually assessed on the basis of their attainment on behavioural objectives identified at the Cognitive, Affective and Psychomotor domains, assessment of the attitudinal aspects of laboratory work is equally important. After completing their Class X by studying a general science course, the students at the +2 level study physics, chemistry and biology as separate disciplines. They are involved in conducting laboratory experiments and projects in the laboratory. At this stage, due to their direct experience in conducting laboratory work, students are likely to form attitudes towards such type of laboratory work. These attitudes probably influence their performance in theory and practicals. There is hence a need to answer with some research evidence the following questions:

- How far does the exposure of +2 students to laboratory work enhance their ability to conceptualize science concepts ?
- To what extent does their attitude towards laboratory work influence their performance in practicals?
- Do background variables such as age, gender, type of syllabi, school and parental background influence their performance in theory and practicals and also their attitude towards laboratory work.

This paper attempts to answer these questions, which may help in improving the quality of science education at the +2 level.

Objectives

The main objectives of the study are:

- To know the influence of attitudes of +2 students towards laboratory work on their performance in theory and practicals.
- To understand the extent to which the background variables like age, gender type of syllabi/school, and parental background influence their performance in theory and practicals, and, also their attitude towards laboratory work.

Procedure

The attitude scale obtained from studies on High School Chemistry in Israel (Walberg, 1967) was adapted by involving teachers of Physics at +2 level and the Physics teachers at the Institute. The scale which consisted of 62 items was validated in the usual manner by conducting a pilot study in some of the local Junior Colleges. Each item was marked on a five point Likert Scale where 5 represents 'fully agree', 4, 'agree', 3, 'undecided', 2, 'partially disagree' and 1, 'fully disagree'. The areas that the inventory covered was related to: (i) students' opinion of the role of laboratory as an instructional tool in +2 Physics, (ii) their opinion of the administrative problems related to laboratory work and (iii) their personal reactions and attitudes towards laboratory work. The items were classified based on whether they measured positive or negative attitude towards laboratory work.

The student sample consisted of 120 students drawn from Central Board of Secondary Education (CBSE), State Government and Private Management schools. The curriculum in physics adopted in these schools were almost similar and emphasized laboratory work.

In order to investigate, the 62 items were classified into eight factors. Factor 1 indicated that students consider laboratory work as specifically a part of the physics learning experience (the number of items were 16). Factor 2 indicated the desire expressed by students for more laboratory work than teachers's lectures (the number of items were 10). Factor 3 referred to the 'value' of laboratory work or its efficiency as a teaching method (the number of items were 16). Factor 4 indicated its value as a means of instruction (the number of items were 4). Factor 5 referred to the 'attitudinal' factor that is indicative of the students' enthusiasm for practical work, and, that he/she enjoys it (the number of items were 6). Factor 6 is a reflection on a comparison between teaching methods involving teacher demonstration and individual laboratory work. It is also indicative of the students' assessment of his own experimentation *vs* teacher demonstration (the number of items were 8). Factor 7 deals with the immediate and future benefits a student gains from experimentation (the number of items were 4). Factor 8 consisted of items which described the advantages of experiments an experimentation (laboratory work) the number of items were 4). The mode of classification adopted here is similar to the studies conducted to Israeli students to assess their attitude towards chemistry laboratory.

Results and Discussion

The data were analyzed using statistical techniques like multiple regression analysis, and 't' tests. The results of the study are presented and discussed below:

Influence of Attitudinal Factors and Achievement in Practicals on Achievements in Theory

In order to find out the influence of all the eight factors of the attitude scale and students achievement in practicals on their achievement in theory, stepwise multiple regression analysis was carried out. The regression analysis was carried out in one step and the results are shown in Table 1.

The obtained multiple R is 0.41, which is significant as per the analysis of variance conducted. The 'F' value is 24.45, which is significant at 0.01 level. As the 't' value of 'B' co-efficient is also significant at 0.01 level, there is a significant multiple correlation between achievement in practicals and criterion achievement in theory. The 'B' co-efficient is 0.36 and it can be interpreted that for every unit increase in achievement in practicals, the achievement in theory increases by 0.36 units.

Out of all the dimensions of attitudes of students towards practicals and their achievement in practicals, only the achievement in practicals is considered to be the predictor of their achievement in theory. Hence the attitudes of students towards practicals does not contribute to their achievement in theory.

Influence of Attitudinal Factors and Achievement in Theory on Achievement in Practicals

Stepwise multiple regression analysis was carried to find out the extent to which the factors in the attitude scale and students achievement in theory influence their achievement in practicals. This was carried out in three steps and the results are presented in Tables 2, 3 and 4.

TABLE 1

Multiple Regression on Criterion Achievement in Theory — Variables entered in Step Number 1, Achievement in Practicals

		ANOVA	*DF*	*Sum of Squares*	*Mean Square*	*F*	*Sig F*
Multiple R	0.41	Regression	1	4241.09	4241.09	24.45	0.00
R Square	0.17	Residual	121	20989.61	173.47		
Adjusted R Square	0.16						
S.E.	13.17						

Variables in the Equation

Variable	*B*	*SEB*	*Beta*	*t*	*Sig t*
Achievement in Practicals	0.36	0.07	0.41	4.95	0.00
(constant)	38.29				

TABLE 2

Multiple Regression on Criterion - Achievement in Practicals— Variables entered in Step 1 — Achievement in Theory

		ANOVA	*DF*	*Sum of Squares*	*Mean Square*	*F*	*Sig F*
Multiple R	0 41	Regression	1	5374.59	5374.59		
R Square	0 17	Residual	.121	26599.42	219.83		
Adjusted R Square	0 16					24.45	0.00
S E	14 83						

Variables in the Equation

Variable	*B*	*SEB*	*Beta*	*t*	*Sig t*
Achievement in Theory	0.46	0 09	0.41	4.95	0.00
(constant	50.62				

The obtained multiple R is 0.41, which is significant as per the analysis of variance conducted. As 'F' value of 'B' co-efficient is significant, there exist multiple correlation between achievement of students in practicals and theory The 'B' co-efficient is 0.46. From this it may be inferred that for unit increase in theory, the achievement in practicals increases by 0.46 units.

TABLE 3

Multiple Regression - Depended Variable-Achievement in Practicals - Variables enteret in Step 2 - Th and factor I

		ANOVA	*DF*	*Sum of Squares*	*Mean Square*	*F*	*Sig F*
Multiple R	0.49	Regression	2	7738.41	3869.20		
R Square	0.24	Residual	120	24235 61	201 96		
Adjusted R Square	0.23					19 16	0.00
S.E.	14.21						

Variables in Equation

Variable	*B*	*SEB*	*Beta*	*t*	*Sig t*
Achievement	0.44	0.089	0.39	4.95	0.00
in Theory T_1	0.51	0.148	0.27	3.42	0.00
(constant)	82.68				

The obtained multiple R is 0.49, which is significant. As the value of 't' is significant, there is a significant multiple correlation between achievement in theory, factor 1, (laboratory work as specifically a part of the physics learning experience) and criterion achievement in practicals.

The obtained multiple R is 0.58. Hence, there is a significant multiple correlation between achievement in theory, factor 1 (laboratory work as specifically a part of the physics learning experience) and factor 2 (more practical work than teachers) of the attitude scale, and criterion achievement in practicals. Out of all the dimensions of attitudes of students towards practicals and their achievement in theory, only the achievement in theory, factor 1 (laboratory work as specifically a part of the physics learning experience) and factor 2 (more practical work than teachers-lectures), dimensions of attitudes are considered to be the predictors of the achievement of students in practicals.

Influence of Background Variables on Attitudes and Achievement in Theory and Practicals

The results pertaining to the influence of various background variables (age, gender, type of school/syllabi and parental background), on students attitudes towards laboratory work, their achievement in theory and practicals, are presented in Tables 5 to 9.

TABLE 4

Multiple Regression – Dependent Variable – Achievement in Practicals – Variables entered in Step 3 – Th, T_1, and T_2

		ANOVA	*DF*	*Sum of Squares*	*Mean Square*	*F*	*Sig F*
Multiple R	0.58	Regression	3	10644.43	3548.14		
R Square	0.33	Residual	119	21329.58	179.24		
Adjusted R Square	0 32					19.8	0.00
S.E.	13.39						

Variables in the Equation

Variable	*B*	*SEB*	*Beta*	*t*	*Sig t*
Achievement in Theory	0 40	0.09	0.36	4.72	0.00
T_1	-0.79	0.16	-0.43	5.06	0 00
T_2	1.05	0.26	0.34	4 03	0.00
Constant	63.49				

TABLE 5

Singificance of 't' between age categories in respect of Attitude towards laboratory work, theory and practical performance

Variable	*Category*	*AM*	*SD*	*N*	*df*	*t*	*Sig t*
Attitude	Less than 20 years	251.43	25.55	110	122	0.05	NS
	20 and above	251.79	24.08	14			
Theory	Less than 20 years	68.92	14.44	110	122	1.02	NS
	20 and above	64.90	8.21	14			
Practical	Less than 20 years	83.58	15.97	110	122	4 05	Significant
	20 and above	69.43	11 78	14			

The value of 't' is significant between the age categories in respect of performance in practicals. This shows that age of students has a significant effect on their performance in practicals but not on their attitudes towards laboratory work and theory performance. Students with less than 20 years of age are found to be superior to their counterparts with 20 and above years of age in performance in practicals.

As the value of 't' is not significant, it may be inferred that male and female students do not differ in their attitude towards laboratory work, theory and practical performance. Hence, sex is found to have no influence on the attitudes, theory and practical performance of students.

Type of school is found to have no effect on altitude towards laboratory work, theory and practical performance

TABLE 6

Significance of 't' between Male and Female Students in respect of Attitude towards laboratory work, theory and practical performance

Variable	*Category*	*AM*	*SD*	*N*	*Df*	*t*	*Sig t*
	Female	251.11	25.54	83			
Attitude	Male	246.12	24.20	41	122	1.67	NS
	Female	67.19	13.73	83			
Theory	Male	71.04	14.07	41	122	1.45	NS
	Female	82.05	16.48	83			
Practical	Male	81.84	15.68	41	122	0.07	NS

TABLE 7

Significance of 't' between types of school in respect of Attitude towards laboratory work, theory and practical performance

Variable	*Category*	*AM*	*SD*	*N*	*df*	*t*	*Sig t*
	State Govt.	249.81	24.36	104			
Attitude	CBSE	260.10	28.82	20	122	1.68	NS
	State Govt.	69.16	13.68	104			
Theory	CBSE	-64.85	14.88	20	122	1.27	NS
	State Govt.	80.84	16.21	104			
Practical	CBSE	87.93	14.85	20	122	1.81	NS

of students, as value of 't' is not significant. Students studying in state schools and CBSE schools do not differ in their attitudes towards theory and their practical performance.

As the values of 't' are not significant for all the variables, it may be inferred that parents' education and occupation

TABLE 8

Value of 't' between different categories of education and Occupation of parents in respect of attitude, theory and practicals

	Attitude	*Theory*	*Practicals*
Father's education	0.29	1.85	0.85
Father's occupation	0.05	0.32	0.24
Mother's education	0.41	0.49	0.85
Mother's occupation	1.44	0.15	1.35

has no influence on attitude towards laboratory work, theory and practical performance of students.

The values of 't' between different categories of sex in respect of factor 4 (value of laboratory work as a means of instruction) and factor 5 (students' enthusiasm for practical work) aspects; type of school in respect of factor 4 (value of laboratory work as a means of instruction) and factor 7 (the immediate and future benefits a student gains from experimentation) aspects; mother's occupation in respect of factor 3 (the 'value' of laboratory work or its efficiency as a teaching methods) and factor 6 (a reflection on a comparison between teaching methods involving teacher demonstration and individual laboratory work) aspects of attitudes of students towards laboratory work, are found to be significant. From this, it may be implied that:—sex differences are evident in factor 4 and factor 6 aspects of attitudes towards laboratory work.

- Students studying in State and CBSE schools do differ in factor 4 and factor 7 aspects of attitudes towards laboratory work.
- Mother's occupation contributes to the attitudes of students in factor 3 and factor 5 aspects.

Except that, all other background variables seem to have no influence on different aspects of students' attitude towards laboratory work.

Summary and Conclusion

One of the new inputs that +2 level students would be exposed to is the laboratory work. Earlier stages of

TABLE 9

Values of 't' between different categories of background variables in respect of aspects of attitude towards laboratory work

Aspects *Variables*	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*
Age	0 57	0 94	0.17	1.39	0.16	0.97	0.17	0.01
Sex	0.86	1.19	0.18	3.76*	0.40	2.53*	1 91	0 51
School Type	1.03	0.85	1.21	2.88*	0.63	0.93	2.63*	1.18
Father's education	0.82	0.93	0.41	0.55	0.94	0.35	0.74	0.13
Father's occupation	0.49	0.09	0.15	1.04	0.74	0.56	0.24	0 59
Mother's education	1.33	0.57	0.77	0.10	0.22	0.16	0.67	0.22
Mother's occupation	1 15	0.03	1.99*	0.16	0 82	2 07*	0.30	0.95

*Significant

education may not provide them with adequate opportunities to manipulate laboratory equipment. As a result of the new experience, students are likely to form attitude towards laboratory work. This study is mainly undertaken to know how far the attitude of students towards laboratory work would help them in their performance in theory as well as practicals The results of this study indicate that the attitude of students towards laboratory work do not influence their performance in theory and practicals. Based on the results of the study the following conclusions can be drawn.

Achievement of +2 students in practicals is a definite indicator of their achievement in theory, whereas their attitudes towards laboratory work is not considered to be a predictor of their achievement in theory. It may be concluded that the achievement of students in theory is independent of their attitudes towards laboratory work. When achievement in practicals is taken as the criterion variable, factor 1 and factor 2 of the attitude scale are found to be the predictors besides achievement of students in theory The attitudinal factors that influence students are laboratory work as an essential part of physics learning experience and more practical work than teachers lectures. From this it may be concluded that besides achievement of students in theory, factors 1 and 2 of the attitude scale are also the potential predictors of their achievement in practicals. Age of the students has no influence on students' attitudes towards laboratory work and their achievement in theory. Age differences are evident in achievement in practicals. As the magnitude of the range of age differences is very less among the students under study, definite conclusions cannot be drawn. Male and female students do not differ in their attitudes towards laboratory work and in their achievement in both theory and practicals Similar results are found in respect of type of school and parental background This indicates that type of school and parental background have nothing to do with attitudes and achievement of students.

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Developing the Mathematics Curriculum

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The mathematics curriculum must be evaluated continuously to stay abreast of recent research results and needed trends. Teaching and learning in mathematics does not stay the same but is subject to modification and change. The psychology of teaching and learning is one area, among others, which is changing and needs to emphasize change in teaching mathematics to students The followings are important to stress in the classroom:

1. Learnings need to be interesting to capture student attention in achieving mathematics objectives of instruction If students lack interest, the chances are that little effort is put forth by the learner to grow, accomplish, and achieve Students interest in learning makes for effort to achieve new heights in mathematics
2. Learnings need to stress purposeful experiences for students. With purpose, the student sees reasons for attaining vital goals in the mathematics curriculum. If purpose is not involved, the chances are a low energy level for achieving will come into being. Each student needs to learn as much as possible in mathematics.
3. Learnings provided for students need to make leeway for individual differences. Students have unique learning styles and reveal content learned in a plethora of ways. Students are unique individually from others and individual differences need adequate provision.
4. Learnings opportunities to achieve objectives should involve active engagement by students Concrete, semi-concrete, and abstract experiences then need to be in the offing. Students learn mathematics with the use of diverse kinds of activities.
5. Learning opportunities need to challenge students to do their very best to achieve optimally. Being satisfied with mediocre or modest achievement is not adequate. Rather, optimal achievement is desired and needs to be expected. Reasonable and high expectations for all students are must!
6. Learnings need to be meaningful. Thus, each student needs to understand that which was presented in ongoing lessons and units of study. Understanding is different from rote learning and memorization. With understanding,

the student can explain facts, concepts, and generalizations in his/her very own words.

7. Learnings acquired in mathematics should be useful. A student then can apply what has been learned. New knowledge acquired should be applied so that retention of subject matter can be maximized. Students forgetting what had been learned makes for lost time in the mathematics curriculum. Retention and use are key concepts to stress in teaching students.
8. Learning activities provided should emphasize students success in goal attainment. Success for students, not failure, is vital in teaching and learning situations. With success, good self-concepts are developed. An adequate self-concept is important in order to achieve optimally in mathematics.
9 Learning opportunities should provide situations whereby a student may be recognized for achievement. students individually desire to be identified within a group for doing well. Each student may then receive praise for doing better than previously in ongoing lessons and units of study in mathematics.
10. Learning opportunities need to be sequenced properly so that the new content to be acquired is built upon what was learned previously. Background information achieved provides that which is necessary to attain the new subject matter (Ediger, 2000, Chapter Seven).

It is then imperative for teachers to use tenets from the psychology of learning in order that students individually achieve as much as possible in mathematics.

How Much Mathematics Instruction Should Students Have?

There is concern over the strong emphasis on reading instruction which might then minimize numeracy development on the part of students. The National Council For Teachers of Mathematics (NCTM) and the National Association for the Education of Young Children (NAEYC) drafted a joint resolution pertaining to appropriate mathematics instruction for 3 to 6 year olds·

"this originated from concerns that we need to send a message about the important of high quality mathematics experiences"... The position statement is the latest in a series of activities over the past few years that has brought early childhood education and experts in math education together.

In 1998, the American Association for the Advancement of Science held a conference for early childhood educators and researchers to talk about mathematics and science for preschoolers With grant money, a document was developed entitled *Engaging Young Children in Mathematics* which contained a description of high quality mathematics experiences for young children and types of materials and activities that teachers can use to develop children's awareness of such concepts as numbers and geometric shapes. In the other section of recommendations, the authors will explain what it takes to equip early childhood teachers with the knowledge and skills to strengthen their teaching of mathematics Simply taking more mathematics courses in college is not the answer.. (Jacobson, 6, September 2001).

With state mandated standards and testing, there is an increasing emphasis being placed on students achieving at a higher and higher level. To achieve state mandated standards for any grade level, students need to start school at an earlier age, such as pre-school. Achievement is measured either through the use of state developed or through standardized tests. State developed tests are more likely to measure what was taught in the classroom, as compared to standardized tests, if the state standards (objectives of instruction) were followed carefully by teachers in teaching and learning situations. Thus, there is increased validity in testing. Additional standards which need to be followed in developing state mandated tests are the following:

(a) These tests have been pilot tested to take out vagueness within test items. For example, word problems need to be clearly written so that each student understands the content and knows what is wanted when responding. Printouts from responses of students to test items provide data for the examiners to evaluate the quality of each test item.

(b) Test results, from pilot studies, should indicate if the test is written at too easy or too complex a level of achievement. If 90% fail the test, then it is written at too complex a level. Or, if 99% pass the test, then the test is written at too easy a level to truly measure learner achievement. It is not possible to locate and describe absolute standards for students to achieve (See *Education Week* of 18th April 2001).

(c) Test results should provide feedback to the teacher in terms of what needs to be taught to remedy deficiencies of each student.

Standardized tests have the following weaknesses to measure student achievement:

1. They tend not to measure in a precise manner what was taught in the local classroom. Why? The tests are not aligned with any set of available objectives. They are global in nature and measure what probably could have been taught nationally in classrooms.
2. They are standardized in that students taking the test are given the same amount of testing time, the same direction for test taking, as well as the same test items. There is no provision made for individual differences in that selected students need more time as compared to others in completing school tasks as well as completing a test or portion thereof. Then too, selected students cannot compete with others when the same test items pertain to all taking the test. Thus, achievement levels differ when comparing one student with the next.

Test results provide numerals to show achievement. This numeral is generally a percentile. A single numeral will not tell much about a student's achievement in mathematics. Additional means need to be used to show progress of learners. A single numeral omits completely what students have learned in mathematics in the daily classroom. To incorporate what students have accomplished in the classroom, a portfolio may be added to the evaluative process to indicate student progress. The portfolio may posses the following:

1. Daily papers of student work from mathematics assignments. By looking at daily student work in mathematics, the viewer can notice specifics in terms of remediation work which needs to be done.
2. Cassette-recordings of committee work of learners. The cassette may reveal the quality of interactions among learners and the knowledge and skills achieved in mathematics.
3. A video-tape showing the student being involved in cooperative learning. Here, viewers of the portfolio may notice the quality of thinking skills and basic ideas achieved.
4. Art products revealing mathematics achievement. Multiple intelligences theory of learning indicates there are a plethora of ways for students to reveal what has be achieved in mathematics (See Gardner, 1993).
5. Construction items made to indicate progress in mathematics. Making place value charts and fraction charts are examples of what students may construct and use to achieve meaning in mathematics. Snap-shots of large items need to become a part of the ensuing portfolio.
6. Written library book reports on mathematics. There are good fiction and non-fiction library books written for grade school students.
7. Diary and log entries kept on concepts and generalizations acquired. The diary entrees incorporate what a student learned in mathematics on a daily basis whereas the logs summarize the diary entries to draw conclusions.
8. Journal writing on personal impressions from ongoing mathematics lessons and units of study. Journal writing is quite open ended in that a student may write about feelings incurred, knowledge gained, as well as skills acquired.
9. Accomplishments from working in peer learning situations. Learning with peers emphasizes learning styles theory (See Searson and Dun, 2001). There are students who work together well in achieving as compared to working by the self Other students may achieve more optimally by working individually on activities and projects.
10. Entries on dramatizations made on certain facts and main ideas gained. Dramatizations can be a good way to emphasize selected learnings like, individuals involved in making set of three and a set of four. The two

sets may be joined together to show that 3+4 = 7 (See Ediger, 1996).

Portfolios are developed by students with teacher guidance to emphasize what a student has learned in the classroom. Standards for portfolio development include the following:

(a) A random sampling of products need to be incorporated. The portfolio should not become too bulky since it needs to be evaluated by at least two appraisers. Careful attention then needs to be given to what goes into the portfolio

(b) The portfolio should indicate improvement from earlier to later performance of the learner. Written work may then be compared to notice improvement in writing from previous attempts.

(c) Viewers such as parents can notice achievement of their offspring.

(d) Portfolios may be used for diagnostic and remedial work. Learner achievement should improve when weaknesses in mathematics are remedied

(e) A well-developed rubric may be used to ascertain student achievement of items contained in the portfolio (Ediger, 2000, 38-44).

Portfolios can provide an excellent example of reporting student achievement to others. The items contained therein are actual and observable to others. The contents evaluated go much beyond a single numeral such as is given for student test results. They are much more difficult to score since it is time consuming to score the entries within each portfolio. Tests may be machine scored in very large numbers and this can be done quickly. Printouts provide numerical feedback for each test item of student responses.

Philosophy of Mathematics Instruction

Mathematics teachers need to be familiar with the philosophy of teaching and learning. A philosophy of instruction provides guidance and direction for the teacher to implement quality instruction. Basically, there are two philosophies which are very important for teachers to know thoroughly.

The first, behaviourism which emphasizes realism as a philosophy of education. Realists believe that the real world can be known as it truly is in whole or in part. They believe it can be described mathematically and scientifically with its many specifics. Behaviourism is used in teaching terminology to describe prior to instruction what students should learn and be able to do with its precise objectives. These objectives are generally developed on the state level by the department of education. High standards and high expectations are the present trends of instruction. These state standards, generally described in measurable terms, indicate what students are to learn/do and are available to mathematics teachers Mathematics teachers need to study and implement these objectives in instruction. Why ? The related state mandated tests should cover what is stated in these objectives. Validity might then be in evidence if the tests truly cover subject matter taught in the classroom. All state mandated tests should be pilot rested to take out the weaknesses and also to determine reliability be it test/retest, alternative forms, and/or split half (Reddy, 2001, 506-510)

From test results, each student then is provided with a percentile to indicate achievement Precision and measurability describe the world of mathematics and science when stressing realism as philosophy of teaching and learning.

Computerized instruction also stresses precision in the teaching of mathematics with its measurably stated objectives and learning opportunities in textbook form or software versions. Software versions generally emphasize tutorial, drill and practice, simulation, and games, (See Ediger, 1998, 62-71).

The second philosophy of education, necessary for mathematics teachers to know and use in experimentalism. Experimentalism is well-expressed by its leading advocate John Dewey (1916). The heart of experimentalism is that human beings cannot know the real world as it exists but can know experiences only. With experiences, there are problems which are encountered. Human beings continuously face problems in life and these need to be solved for life to continue. In school mathematics, students need to experience life like situations whereby answers are needed. Word problems in textbooks may not represent daily mathematics problems experienced by learners. School and society are to be one and not separate entities, according to experimentalists. People live in society and here is where problems need solutions. Whatever is a life like problem to a student might well then become problems for solution in the classroom. Thus, if a student asks about the present day temperature reading and wants to know how many degrees lower it is than yesterday, the learner needs to be aided in finding the difference between the two, such as 75 minus 48 degrees, for example. Or, a student has $6.25 and needs to have $22.98 to buy a new baseball glove, how much more money does the student need ? The teacher may structure the classroom environment with mathematics problems which are daily encounters which need solutions. For example, good teachers have developed a miniature supermarket which resembles one in society. The miniature supermarket exemplifies, to the best possible, what is in the societal arena. Students and the teacher may bring empty food containers to class. Prices may be attached to each container, according to the developmental level of the involved learners. Toy money may then be used for students to "go shopping" for food items involving the containers brought from home. The following pointers are salient for the mathematics teacher to remember when implementing experimentalism as a philosophy of teaching and learning·

1 There needs to be input from students in developing the curriculum. Students then have problems which need solution involving mathematics. Time needs to be given in finding answers.

2. The classroom environment needs to be arranged so that what exists in society may be implemented in terms of becoming a part of the mathematics curriculum.

3. The mathematics curriculum needs to be made as life like as possible, relating the learning opportunities to the personal experiences and interests of students. Interest in learning makes for effort to achieve. The student then does not become separated from the mathematics curriculum but becomes wholeheartedly involved with teaching and learning.

4. The student with teacher guidance needs to:
    (a) choose a life like problem involving mathematics which has personal value.
    (b) gather information from a variety of sources in answer to the problem.
    (c) develop an hypothesis from the accumulated information.
    (d) test the hypothesis in a life-like situation, not through a paper pencil test.
    (e) modify and revise the hypothesis if necessary.

5. Emphasize a student-centred sequence as much as possible whereby the learner orders his/her own experiences. This can be compared with a logical mathematics curriculum in which the teacher sequences learning opportunities for students.

6. Content taught from basal textbooks should be related to mathematics experiences in everyday life. The teacher needs to make content life-like for students as would be experienced in society. The school mathematics curriculum is then not separated from what transpires in the real world.

7. Thought, deliberation, and reflection are needed when implementing the mathematics curriculum. This is especially true of problem-solving experiences.

8. Purpose in learning is salient in that the learner needs to perceive the values of learning what is life-like in the school/societal mathematics curriculum.

9. Meaning theory needs to be inherent in mathematics. What is meaningful to students then is important, not rote learning and memorization. Understanding of subject matter is vital in the mathematics curriculum.

10. The attitudinal dimension cannot be separated from knowledge and skills used in problem-solving (Ediger, 1999, 5-9).

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Impact of Using Simple Techniques in Mental Arithmetic

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There is a positive correlation between civilization and the development of mathematics. The history of civilization shows that man has always felt the need for counting, measuring and weighing The basic knowledge of mathematics is vital in the life of any person whether he is a coolie or a tailor, a carpenter or a mason, a clerk or an intellectual. Daily transactions can be completely done only if such persons have a basic knowledge of mathematics.

One of the objectives of teaching mathematics is to enable children to solve numerical problems to the best of their capacity with sufficient speed and accuracy. Mathematics develops the ability to reason logically and express thoughts precisely, clearly and accurately. The Education Commission (1964-1966) also recommended mathematics as a compulsory subject for school students.

Mental Arithmetic

We do mental calculations in many situations where the four fundamental operations, namely, addition, multiplication, subtraction and division are involved. For example, during a bus journey neither the conductor nor the passengers use a calculator or a paper and pencil to calculate the fare or the balance to be returned. Mental arithmetic comes under intensive use in:

- the purchase of household items
- counting coins and currency notes of different denominations
- handling the accounts of family such as purchase of milk, laundry and transportation
- determining one's age
- finding the number of days between two dates
- determining time
- entertainment through mathematics

Simple techniques

Using simple techniques in mental arithmetic gives practical power to theoretical knowledge and makes men of learning giants in action For example, the total quantity of milk purchased in 30 days at the rate of 1.5 litres per day can be calculated easily by adding 30 and 15. Similarly, the cost for 45 litres of milk at the rate of Rs. 11 per litre can be worked out easily by adding 450 and 45, that is, Rs. 495.

Simple techniques enable us to do calculations quickly and easily. The following are some of the simple techniques which can be followed in doing the four fundamental operations. These methods are prescribed in the mathematics syllabus of Class VI and Class VII in Tamil Nadu.

Example 1

Add 75 and 27

$75 + 27 = 75 + 25 + 2$

$= 100 + 2$

$= 102$

Example 2

Subtract 78 from 180

$180 - 78 = 180 - 80 + 2$

$= 100 + 2$

$= 102$

Example 3

Multiply 72 by 5

$72 \times 75 = 70 \times 5 + 2 \times 5$

$= 350 + 10$

$= 360$

Example 4

Divide 250 by 5

$250 \div 5 = (250/10) \times 2$

$= 25 \times 2$

$= 50$

Objectives

The study had the following objectives:

1. To find out the speed and accuracy of Class VI pupils in doing mental arithmetic.
2. To teach the simple techniques and practice the pupils of Class VI to apply the techniques in mental arithmetic.
3. To find out the speed and accuracy of the pupils after using the simple techniques in mental arithmetic.
4. To compare the speed and accuracy in doing mental arithmetic in the pre-test and post-test among: (i) boys, (ii) girls, (iii) rural, (iv) urban and (v) entire sample.
5. To find out whether there is a significant difference in the post-test results of. (i) boys and girls and (ii) rural and urban pupils.

Methodology

Sample

The sample consisted of 14 boys and 19 girls of Class VI in Government Middle School at Nallur village and 18 boys and 24 girls of Class VI in Government Middle School in Nagercoil town

Tools

Two question papers of equal standard were prepared by the researcher to conduct the pre-test and the post-test Simple techniques in addition and multiplication prescribed for Class VI in Tamil Nadu were taken into consideration. The question paper contained 10 questions on addition and 10 questions on multiplication It was a timed test to find the speed and accuracy. The pupils were not allowed to write anywhere other than the boxes provided to write the answers. So all the pupils were compelled to do the calculations mentally Equal weightage was given for every correct answer, and the total score of each pupil was converted into percentage

Analysis of Data

The performance of pupils in the pre-test based on speed and accuracy in mental arithmetic before practising the simple technique and their performance in the post-test after practising the simple techniques is shown in Table 1

There is an improvement in the mean scores of boys from 66 56 to 83.59 and

TABLE 1

Comparison between pre-test and post-test scores

Category	*Sample size*	*Pre-test*		*Post-test*		*t-value*	*Result*
		Mean	*S.D.*	*Mean*	*S.D.*		
Boys	32	66.56	15.1	83.59	13.51	4.76	Significant
Girls	43	68.02	10.64	86.04	10.09	8.04	Significant
Rural	33	66.82	13.45	85.46	12.77	5.77	Significant
Urban	42	67.86	12.15	84.64	10.84	6.69	Significant
Entire Sample	75	67.4	12.66	85	11.65	8.85	Significant

girls from 68.02 to 86.04. The mean score of rural pupils improved from 66.82 to 85.46 and urban from 67.86 to 84.64. As far as the entire sample is concerned the score goes up from 67.4 to 86 showing a net improvement of 17.6 per cent. There is a significant difference at .01 and .05 level of significance in the pre-test and post-test scores of boys, girls and rural, urban and the entire sample.

Table 2 shows the comparison between the post-test scores of boys and girls, rural and urban pupils. There is no significant difference between boys and girls of Class VI. Similarly, there is no significant difference between rural and urban pupils at .01 level of significance.

Major Findings

Using simple techniques in mental arithmetic has increased the speed and accuracy of Class VI pupils. There is no significant difference either among boys and girls or among rural and urban pupils in the speed and accuracy in doing mental arithmetic.

TABLE 2

Gender-wise, Locale-wise comparison of post-test scores

Category	*Sample size*	*Post-Test*		*t-value*	*Result*
		Mean	*S.D.*		
Boys	32	83.59	13.51	0.86	Not Significant
Girls	43	86.04	10.09		
Rural	33	85.46	12.77	0.29	Not Significant
Urban	42	84.64	10.84		

Conclusion

Since the achievement in the external examination is considered as the index of pupils' level of learning mathematics, present mathematics teaching concentrates on preparing the children for external examination. As a result the practice of applying simple techniques in mental arithmetic is neglected by the teachers.

Solving arithmetic problems mentally keep the mind alert and active. Using simple techniques develops speed and accuracy. It saves a lot of time and cuts short the process that would have to be unnecessarily done in written arithmetic. Even though we have calculators to do arithmetic calculations, practical application of mental calculations in daily life cannot be denied. By using simple techniques, one could do the mental arithmetic calculations even before taking out the calculator from his/her pocket So it is important that teachers should encourage the children to use simple techniques to work out arithmetic calculations mentally.

Formation of Concepts in Science and Socio-Economic Status in Primary School

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A concept refers to a symbolic representation of some common or shared characteristic or characteristics of events or objects. The ability of the human beings to form concepts enables them to categorise, things and objects into classes. Development of concepts involves perception, abstraction, generalization and discrimination. The child gets the knowledge of the external world through the senses, which are the gateway of knowledge. Things in our immediate environment stimulate our sense organs. Our minds read it and we become aware of the things. This process is called sensation. The child perceives a number of objects in the world. The child recognizes that some objects are dissimilar in certain respects. Then the child obstracts the similarities and dissimilarities and organizes the common properties of the object. Thus, sensation and perception are the two stages which lead to concept formation.

Rationale for the Study

Perception level of the primary children is high as most of the concepts is new for them. They like novelty in learning, too. Formation of the concepts at the primary stage lays the foundation to the future development of the concepts. When the students comprehends the concepts correctly through real objects and models, the pace of concept formation goes up enormously and in the desired direction. According to Piaget (1958), the concrete operational stage of 7 to 11 years old is very crucial for the concrete level of learning. Formation of concepts in science is believed to be difficult as compared to other subjects. Hence, the science teachers are expected to use teaching aids like charts, model, real objects, etc. for better and clear understanding. The investigators were interested to know how the level of formation of concepts get affected by the use of aids in science teaching. This has motivated the investigators to conduct a study in this area.

Objectives of the Study

The objectives of the study are:

(i) To study the level of concept formation in Science among standard V Students.

(ii) To find out the relationship between formation of concepts in science and Socio-Economic Status.

Methodology

The nature of the experiment was pre-post-test single group design. Teaching science through real objects and models was the independent variable and the Development of concepts in science was the dependent variable. The co-variable in the study was socio-economic status of the Class V students.

(a) Sample for the Study: Twenty students studying in Class V in Anita Kumaran Matriculation School, Thandupatu were taken as sample for the study. The selected students were administered pre-test on the fifteen selected concepts. After the treatment was over post-test was conducted to measure the level of formation of concepts.

(b) Tools Used: The tools of Mastery Test in science, developed by the investigator Aaron's Socio-Economic Status Scale and Annual Examination Scores in Tamil, English, Mathematics, Science and Social Sciences were employed for the collection of data.

(c) Development of Mastery Test: The 15 science concepts from Class V science textbooks were identified. Fifty-three multiple choice questions, having three alternatives were prepared based on the 15 concepts, such as reproduction by seeds, vegetative propagation, hypogeal, epigeal, monocotyledon, dicotyledon, submerged hydrophyte, solar eclipse, lunar eclipse, total and partial eclipse. Then it was administered to 22 students of Class VI. The Mastery Test was scored and the appropriate formulae were used to find out the difficulty value and four items were discriminatory index. Totally 6 items were deleted. Hence, there were 47 items for the final draft. The final draft was administered to the Class V students of another school. After 15 days the same students were tested with the same drafts. Correlation co-efficient was found between the two set of scores. This was the co-efficient reliability test which was r = 0.86.

(d) Statistics used in the Study. The gain scores were used for finding the level of concept formulation in science and to test the hypotheses. The investigator used Mean, Standard Deviation, Percentage, Co-efficient Correlation and Sandlers 'A' test to analyse the data.

Analysis of the Data

The data collected through experimentation were processed and reported in the form of tabular columns. The analysed data are presented in the following four tables.

The students were classified into three on the basis of t-scores of mastery test. Those who have got t-scores below 40 are named students at low level concept formation in science. Similarly, scores varying between 41 to 60 were named as middle level of concept formation and above 61 named were as high level of formation of concepts in science. The results of the level of formation of concepts in 15 separate concepts are presented in Table 1.

Table 1 indicates that more than 80 per cent of students had high level of concept formation for the four concepts such as reproduction by seeds, floating hydrophyte, amphibious hydrophyte and lunar eclipse. The 70 per cent of students had high level of concept formation for the other four concepts. It

TABLE 1

Level of Formation of Concepts in Fifteen Concepts in Science

Sl. No.	*Name of Concept*	*Level of concept formation*					
		No. of students			*percentage of Students*		
		High	*Middle*	*Low*	*High*	*Middle*	*Low*
1.	Reproduction by seeds	17	3	-	85	15	-
2.	Vegetative Propagation	14	4	2	70	20	10
3.	Grafting	14	3	3	70	15	15
4.	Layering	8	9	3	40	45	15
5.	Monocotyledons	8	11	1	40	55	5
6.	Dicotyledons	8	9	3	40	45	15
7.	Hypogeal Germination	15	4	1	75	20	5
8.	Epigeal Germination	14	5	1	70	25	5
9.	Floating Hydrophyte	16	3	1	80	15	15
10.	Submerged Hydrophyte	11	8	1	55	40	5
11.	Amphibious Hydrophyte	16	3	1	80	15	5
12.	Solar Eclipse	13	6	1	65	30	5
13.	Lunar Eclipse	18	2	-	90	10	-
14.	Total Eclipse	11	7	2	55	35	10
15.	Partial Eclipse	8	9	3	40	45	15

is quiet interesting to note that 55 per cent of students had middle level of concept formation for the concept monocotyledons and 45 per cent of students for the concepts of layering, dicotyledons and partial eclipse. There were no students having low level of concept formation for the concepts of reproduction by seeds and lunar eclipse and only 5 to 15 per cent of students were low level of concept formation in all the remaining 12 concepts.

Aaron's SES scale was administered to measure whether there is any relationship between formation of concepts in science and Socio-Economic

TABLE 2

Correlation between Formation of Concepts in Science and Socio-Economic Status, Parents Profession and Education

Sl. No.	*Different Concepts*	*Df*	*t-value*	*r-value*	*Level of Significance**
1.	Socio-Economic Status	18	2.10	0.3208	0.05
2.	Parents' Profession	18	2.10	0.3150	0.05
3.	Parents' Education	18	2.10	0.2995	0.05

* No Significant Relationship

Status in total and profession of the parents and education of the parents separately. The findings are presented in Table 2.

Table 2 shows that the r values are 0.3208, 0 3150 and 0.2995 which demonstrate that there is no significant relationship between formation of concepts in science and socio-economic Status. The same result was found when the relationship was tested with Parents Profession and Parents Education separately at 0.05 level of significance.

Findings

The findings of the study are given below:

(i) For the two concepts namely reproduction by seeds and solar eclipse, the level of concepts formation were high and middle for the 85 and 15 per cent of the students respectively.

(ii) 70 to 90 per cent of the students had high level of concept formation for eight concepts.

(iii) 40 to 55 per cent of students had middle level of concept formation for five concepts.

(iv) 5 to 15 per cent of the students were at the low level of concepts formation for 13 concepts.

(v) There was no significant correlation between formation of concepts in science and socio-economic status on the whole as well as separately between formation of concepts in science and parents profession and parents education.

Discussion

As a whole 70 per cent of the students had comprehended well the science concepts. When the 15 concepts were taken for analysis separately, two concepts were well-comprehended by all the students and nine concepts were well comprehended by the majority of the students. Four of the concepts, namely, grafting, layering, dicotyledons and partial eclipse were comparatively less comprehended by the 15 students. Perhaps these four concepts may be of a higher order for this age group requiring imagination of the student's for better comprehension. In general, teaching through real objects and models had made the formation of the concepts well.

The formation of concepts in science was not related to the SES of the students. The investigator provided activities of real objects and models in the treatment to develop concepts in science to the sample of the study. The impact of the family background on the formation of concepts in science was insignificant. Further it was also found out that the formation of concepts in science was negatively related. This has to further probed into.

Conclusion

All the primary school teachers are to be motivated/encouraged to teach all the science concepts with real objects and models, as the study found the significant impact of using real objects and models in enhancing concept formation in science. The Government may provide certain important aids and distribute them to all the primary schools. Guidelines may be given to the teachers on when and how to use these materials to the children effectively. The primary school teachers are to be given in-service training regularly on how to prepare improvised aids and also how to make use of the cheaply available local resources to prepare aids for teaching. Teachers should not discriminate the students on the basis of socio-economic status. Teachers should encourage to give equal importance to all the students irrespective of socio-economic status.

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Science News

Water Discovered on Mars

Researchers have announced that the analysis of the data received from NASA's Global Surveyor Spacecraft have indicated signs of water seeping into what appear to be young, freshly-cut gullies and gaps in the Martian surface. The startling discovery of recently formed, layers of rock with water seeping from them and sediment has puzzled the experts on planetary studies because it doesn't really fit in their models of what Mars is like. The wet spots have been seen in more than 120 locations on Mars and in the coldest places on the planet, according to Michael Malin of Malin Space Science Systems in San Diego, California, USA. This information has posed a perplexing problem to the researchers because logic says that Mars sub-zero temperatures and thin atmosphere should have kept those wet spots from ever forming. These wet spots, have appeared in 200 to 250 different images from the Global Surveyor Spacecraft it is guessed that these spots could be a few million years old but scientists are not in a position to rule out that some of them could be very recent in their origin.

One of the plausible explanation put forward by the scientists is that the presence of water on the Mars could be due to repeated outbursts that might be occurring on the planet, similar to flash floods on Earth.

The water supply is believed to be about 100 to 400 metres below the surface and limited to specific regions of Mars, according to a NASA release. Each flow that came down each gully may have had a volume of water enough to sustain 100 households for a month. According to Ed Weiler, NASA space science chief what Malin and Edgett have found is "very intriguing" and holds "profound implications" for the possibility of finding past or present life on the Mars.

However, Weiler cautions that it may be too early to jump on any conclusion as the data must undergo further scientific scrutiny because in science every hypothesis has to be proved and a lot of work need be done to arrive at that stage. He cautioned against jumping to conclusions. So far no lakes or rivers nor hot springs have been found on Mars. However, the finding does appear to have pushed forward the theory of when Mars — once wet and warm — might have lost all its water. The latest find could set that clock back to perhaps a million years ago, perhaps a thousand years ago, perhaps yesterday.

If the findings can be confirmed, it would imply that Mars is not geologically dead, says Wes Huntress, NASA's former space science chief and now director of the Geophysical Laboratory, Carnegie Institution of Washington. He further elaborated that scientists believed that there's really water below the surface but didn't knew where it was.

Global Surveyor was launched in 1996 to make a detailed map of Mars with a suite of instruments designed to provide new details about the planet's craggy surface. But scientists caution that finding water isn't a valid reason to rush into a decision to send humans to the planet The discovery first requires confirmation and then should be studied much better by a series of spacecraft both orbiting the planet and landing on its surface.

The news that Mars holds vast stores of water ice right near the surface and away from the permanently frozen south polar ice cap was announced earlier in March 2002 by the scientists who were analyzing the data received by them from NASA's Mars Odyssey spacecraft. William Boynton, a University of Arizona researcher who is the principal investigator for the Gamma Ray Spectrometer suite of instruments on board Odyssey, while announcing the discovery made by his team scientists said that there's a lot of ice on Mars because the signals they have received so far are very strong That signal is of hydrogen, one component of water. Boynton and his colleagues were confident that their new measurements represent actual water ice at the surface and down a few metre. However, they were of the opinion that additional observations are needed to confirm the results. The additional information has come up within a few months supported with the data from Global Surveyor. Boynton said the northern hemisphere of Mars might contain similar amounts of water ice, but that won't be determined until it is summer there and the large polar cap recedes. The cap's seasonal component is largely carbon dioxide ice and it masks what might be underneath.

Scientists have long suspected that water once flowed freely on a warmer Mars Supporting evidence has mounted in recent years, mostly due to the data and imageries sent by the Mars Global Surveyor Spacecraft orbiting the planet. It was believed that as the Mars cooled millions or billions of years ago its surface water froze or evaporated into space through a thinning atmosphere, some may have remained frozen in the soil or trapped in underground reservoirs. Some scientists have speculated that heat from within may still have left some of that water in liquid form. Or, underground water ice might be periodically melted by this geothermal activity. These speculations were accepted in spite of the fact that research so far has not shown conclusively whether Mars is still geothermally active. Surveyor's most significant discovery in the form of the evidence of seasonal deposits that could be associated with surface springs was first reported by in the middle of year 2000.

Odyssey was launched on 7 April 2001. The spacecraft is 2.2 metre long, 1.7 metre tall and 2.6 metre wide. The orbiting craft will study Mars for at least three years from a distance of nearly 400 kilometres from above. It will map the planet in visible and infrared light in unprecedented detail, according to scientists. Odyssey is also scheduled to measure potentially deadly radiation with the Martian Radiation Environment Experiment (MARIE), an instrument that so far has not been made to work. Engineers are developing solutions and remain hopeful that MARIE will function.

Surveyor and Odyssey will both continue to explore Mars for more signs of liquid water on and below the surface. The next planned mission planned for exploring Mars is a pair of robotic surface rovers that would be launched in 2003. The overs will be able to shift dirt and crack upon rocks, then photograph the results and analyze sample for chemical signs of water and life. The new findings and other results expected from Odyssey will help scientists decide where to put the rovers.

BARC Establishes Nuclear Science Centre in Vietnam

India and Vietnam have further strengthened their collaboration in the field of nuclear sciences, by establishing 'Vietnam- India Nuclear Science Centre' (VINSC) at Dalat, Vietnam, by Bhabha Atomic Research Centre (BARC). Mr B. Bhattacharjee, Director, BARC, and Vietnam's Vice Minister of Science, Technology and Environment, Dr. Hoang Van Huay inaugurated VINSC, on 10 January 2002.

A number of indigenously designed and manufactured laboratory equipment were supplied and installed at VINSC, Dalat by BARC scientists and engineers. Setting up a centre of this kind outside the country, with all indigenous equipment, was a unique experience for BARC engineers/scientists. Efforts put up by different agencies and individuals that were involved in this endeavour that required meticulous planning and execution skills to complete the assignment within the stipulated time, is really commendable. The assignment according to the experts was truly a multidisciplinary and multiorganizational time-bound activity. The setting up of such a state-of-the-art centre as VINSC with complete indigenous know-how and technology demonstrates the synergetic strength of BARC in the field of nuclear science and technology.

New Amino Acid Discovered

Two teams of researchers from Ohio State University have reported that they had identified the 22nd genetically encoded amino acid, a discovery that is the biological equivalent of physicists finding a new fundamental particle or chemists discovering a new element. For 30 years after the discovery of the structure of DNA and the unravelling of the genetic code, scientists believed that there were only 20 natural amino acids. Then in 1986, researchers broke that numerical barrier announcing that the 21st had been discovered. Finding a 22nd suggests that even more of these basic biological building blocks may be found using modern genome sequencing techniques.

The discovery grew out of some very basic bio-chemistry examining how a particular type of microbe — methanogens — can convert methyl-containing compounds into methane. While researchers have long understood the bio-chemical mechanisms for how acetate and carbon dioxide are converted to methane, they didn't understand how a common class of compounds — the methylamines — are transformed into this gas.

One research group, led by Joseph A. Krzycki, an Associate Professor of Microbiology, had been working for several years with a particular strain of microbe, Methanosarcina barkeri. This organism, a member of the recently identified domain Archaea, is able to convert monomethylamine, dimethylamine and trimethylamine into this greenhouse gas. Krzycki's research group had isolated specific proteins related to the process in 1995 and, two years later, they had isolated and sequenced one of the genes responsible. Then in 1998, they published a paper showing that the gene had a component called an in-flame amber codon that behaved unusually.

Codons are three-letter 'words' identifying the bases DNA uses to specify particular amino acids as building blocks of proteins. Normally, codons signal the start of a protein, its end or a particular amino acid used to construct it. Surprisingly, the codons Krzycki's team identified should have signaled a stop to protein building but it did not. The second research team that identified and determined the structure of the amino acid was led by Michael Chan, an Associate Professor of Bio-chemistry and Chemistry at Ohio State, USA. Reacting to the findings of the other research group Chan observed that they have found this happening in genes important for all three of the methylamine compounds — something that wasn't supposed to happen. The realization of the codon's odd behaviour suggested the possibility of a new amino acid, but the researchers knew there might be other explanations as well.

Krzycki and his colleagues sliced the protein into smaller bits called peptides, and began sequencing them, a process which usually ultimately reveals the amino acid responsible for the protein. According to Chan, that all seemed to point to this being just lysine, one of the normal amino acid. However, regardless of these, Kyzycki asked Chan and Ph.D. student Bing Hao to start working on deducing the crystalline structure of the protein containing the amino acid. At the end of the two-year process, Hao and Chan had determined the structure of the protein, part of which revealed a new amino acid.

At the same time, Krzycki was looking for other evidence. He, along with doctoral students Gayathri Srinivasan and Carey James, was eventually able to identify 'the specific transfer-RNA (tRNA) needed to insert the new amino acid into protein, as well as another important enzyme essential to the process. These two discoveries, along with the detailed crystalline structure, convinced the teams that they had found a new genetically encoded amino acid — pyrrolysine — the 22nd known to science.

Krzycki realized that he has to know which tRNA would decode that amber codon and finding it was an essential part of the puzzle they were to solve. He believes this will be a very rare amino acid, given the fact that it has taken so long to identify it. However, Krzycki believes it is likely to be found in other situations — in other organisms — aside from methanogens. According to him this shows us that the genetic code, and therefore, evolution is much more plastic than people might have thought. Chan agrees, pointing to the strong possibility that finding a 22nd genetically encoded amino acid should stimulate the search for a 23rd or a 24th. His argues that with so many researchers dissecting so many genomes now, it's reasonable to suggest that there might be more painting to be found. Chan believes that this work will cause researchers to start looking at genetic sequences that they might have thought at first were simply aberrations. Instead, they might signal discoveries like ours.

Scientists Learn Something New About One of the Most Studied Chemical Reactions

The simplest and best-studied chemical reaction — the collision of a hydrogen atom H with molecular hydrogen H_2 is still unveiling its mysteries to scientists. Experimentalists from Stanford University (USA) and theorists from the University of Durham, (UK), have reported a surprising new observation: As a result of the collision, a tiny proportion of H_2 molecules is flying off in an unexpected direction. According to Richard N. Zare, the Marguerite Blake Wilbur Professor in Natural Science, at Stanford University, these experiments were done really to understand chemistry in a deep, profound way. It is to get the mystery of how chemical reactions occur.

When a hydrogen atom (H) collides with a hydrogen molecule (H_2), the collision breaks the original bond between two hydrogen atoms in H_2 and forms a new bond as one of those hydrogen atoms bonds to the incoming H. This reaction usually occurs when the three H atoms lie in a straight line.

To follow this hydrogen-exchange reaction, scientists shot hydrogen atoms at molecular heavy hydrogen D_2), so that the HD reaction product could be distinguished easily from the initial H_2 reactant. Using a sophisticated laser technique developed at Stanford, Zare and his colleagues measured the spread of the reaction product, HD, in space. Usually, the newly formed hydrogen molecule departed in the opposite direction as the motion of the incoming atom. But to the surprise of the scientists, they found that a tiny fraction of the newly formed HD product moved in the 'wrong' direction. Instead of bouncing back toward the incoming H atoms, some HD traveled in the opposite direction. Zare and his colleagues further noticed that this reaction occurs slightly later than the immediate hydrogen-exchange reaction. These findings suggest more than one mechanism by which H and D_2 come together and react. The researchers are not sure about the cause of this delay cause is, but believe that it is some form of trapping.

Experiments that follow this tiny part of the reaction are extremely difficult to perform because the free hydrogen atoms don't exist naturally and need to be created for the experiment. Zare used laser photochemistry to create free hydrogen. Newly created H atoms are made to react with molecules in a jet of D_2 to create HD. Using the laser system and a method called 'photoloc,' Zare can record the appearance and 'travel direction' of HD as well as the speed at which the newly formed HD molecule vibrates and rotates.

The other team of researchers led by Stuart S. Althorpe at the University of Durham, (UK) developed a new simulation method, using computers to 'observe' the reaction at the quantum mechanics level. It is the first time scientists simulated the hydrogen reaction from start to finish calculating the scatter of the reaction products into space at such a high level of sophistication. According to Zare, the theoretical work done in Durham is a breakthrough by itself. Due to the uncertainty principle of quantum mechanics, the simulation can't determine any specific position of an HD product. Instead, it calculates a cloud of the most likely positions only. It is common knowledge that quantum mechanics doesn't allow to make simultaneous measurement of basic parameters of individual molecules. According to Althorpe even the act of photographing individual molecules would alter their behaviour and change the outcome of the reaction. But with the simulation, Althorpe and Zare could use experimental measurements to infer what atoms are doing over the whole reaction time.

The outcome of the research study has a special significance because although more than a thousand papers have been written about the hydrogen exchange reaction, but this is the first study combining theory and experiment that points to a new time-delayed reaction mechanism. Commenting on the findings of the study, Nobel laureate Dudley Herschbach of Harvard University observed that this result is very surprising for a system people had thought is now pretty well understood. Despite 70 years of research, chemists haven't achieved full correspondence between theory and experiments. We are still discovering fresh, unsuspected aspects that apply for all chemical reactivity. Another renowned chemist George Schatz of Northwestern University observes that the purported existence of time-delayed mechanisms is a controversial area of chemistry. The quality of the theory always left a bit of uncertainty. But now all seems to work and it provides an extraordinarily intricate picture of what happens when H hits D_2.

Scientists Virtually Finish Draft of Mouse Genome

Nearly after two years of publishing the sequence of the human genome, scientists have now claimed that they had virtually finished the genome map of the mouse — and are already finding tantalizing similarities between mice and men. The researchers have found that the mice, already believed to be genetically similar to humans, have virtually the same number of genes, about 30,000. Surprisingly, the mice too, have been found to carry the same 'junk DNA.'

The researchers from the National Human Genome Research Institute are confident that this information will allow them to gain insights into the function of many human genes because the mouse carries virtually the same set of genes as the human but can be used in laboratory research. For most human illnesses, from cancer to autoimmune disease, important insights have come from the study of mouse models. The advanced draft of the mouse sequence is expected to speed up the process of identification of genetic contributors to those illnesses in humans, as well as improved tests and treatments.

A genome, as every student of biology knows is the collection of all genetic material, and a draft genome sequence is something like a rough map. Some experts have likened a draft sequence to a map that shows the major highways but does not name roads, cities or towns. Researchers still are not sure how many genes a human has, much less where they all are. The collection of nucleotides that make up the genome include not only genes but also repeat sequences, 'junk DNA,' and factors that control the genes.

Dr. Francis Collins, Head of the National Human Genome Research Institute says that he was not surprised to see mice have the same genes as humans, but he was surprised to see they had the same 'junk DNA.' This is content that we don't understand and don't recognize what it is. Is this DNA involved in regulation? Does it turn genes on and off? Could it be new genes that we don't recognize? These are some of the pertinent questions, answers to which are not known to the researchers as yet. What is now clear is that 'junk DNA' is not unique to humans and it is important enough to have lasted through the millions of years of evolution that separate mice and people.

The team, including researchers from the National Human Genome Research Institute, Massachusetts Institute of Technology, Washington University in St. Louis, Cambridge University in Britain and elsewhere, said the mouse genome is about 2.7 billion base pairs in size, or about 15 per cent smaller than the human genome. The human genome is 3.1 billion base pairs spread out over 23 pairs of chromosomes.

However, according to Eric Lander, Director of the Whitehead Center for Genome Research at MIT, the mouse sequence provides a very important chapter from evolution's lab notebook. That's because evolution preserves the most important genetic information across species — if specific DNA sequences have been preserved by evolution over hundreds of millions of years, then they must be functionally important.

Striking Portrait of a Solar System in its Infancy

A team of astronomers have discovered a dusty and opaque disk surrounding a young solar-type star on the outskirts of a dark cloud in the Milky Way. It was found by chance during an unrelated research programme and provides a striking portrait of what our Solar System must have looked like when it was in its early infancy. Because of its unusual appearance, the astronomers have nicknamed it the 'Flying Saucer.' The discovery was made using the European Southern Observatory (ESO) 3.6-m New Technology Telescope and the Very Large Telescope (VLT).

The new object appears to be a perfect example of a very young star with a disk in which planets are forming or will soon form, located far away from the usual perils of an active star-forming environment. Most other young stars, especially those that are born in dense regions, run a serious risk of having their natal dusty disks destroyed by the blazing radiation of their more massive and hotter siblings in these clusters.

The star at the centre of the Flying Saucer seems destined to live a long and quiet life at the centre of a planetary system, very much like our own Sun. This contributes to making it a most interesting object for further studies with the VLT and other telescopes. The mass of the observed disk of gas and dust is at least twice that of the planet Jupiter and its radius measures about 45 billion km, or 5 times the size of the orbit of Neptune. Planets form in dust disks around young stars. This is a complex process about which not all stages are yet fully understood, but it begins when small dust particles collide and stick to each other. For this reason, observations of such dust disks, in particular those that appear as extended structures (are 'resolved'), are quite important for our understanding of the formation of solar-type stars and planetary systems from the interstellar medium.

In most cases, the large difference of brightness between the young star and its surrounding material makes it impossible to image the circumstellar disk directly. But when the disk is seen nearly edge-on, the dust grains in the disk will block the light from the central star out. Other grains below and above the disk midplane scatter the stellar light, producing a typical pattern of a dark lane between two reflection nebulae. It may be recalled that the first young stellar object (YSO) found to display this typical pattern was imaged by the Hubble Space Telescope (HST) in 1996. It has been given the name 'HH 30 IRS' and is located in the Taurus dark cloud at a distance of about 500 light-years (140 pc). Edge-on disks have since also been observed with ground-based telescopes in the near-infrared region of the spectrum, sometimes by means of adaptive optics techniques or speckle imaging, or under very good sky image quality.

The discovery is yet another example of a chance discovery but for the keen observational skills of the researchers. In 2001, the same group of astronomers carried out follow-up observations of new X-ray sources found by the ESA XMM-Newton and NASA Chandra X-ray satellites. They were looking at the periphery of the so-called Rho Ophiuchi dark cloud, one of the nearest star-forming regions at a distance of about 500 light-years (140 pc), obtaining images in near-infrared light with the SOFI multi-mode instrument on the 3.5-m New Technology Telescope (NTT) at the ESO La Silla Observatory (Chile). On one of the NTT photos obtained on 7 April 2001, they discovered by chance a strange object, which by closer inspection turned out to be a resolved edge-on circumstellar disk, so far unnoticed and displaying infrared scattered light around a young star. To confirm this discovery and to learn more about the object and the disk, the astronomers obtained additional information by special techniques.

A series of fine images was obtained on 15 August 2001, under very good observing conditions (with "seeing" of 0.4

arcsec). Now the two reflection nebulae were clearly seen, and the dark dust lane was well-resolved. The leader of the group, Nicolas Grosso, recalls the first impression when seeing the true shape of the object: "That is when we looked at each other and, with one voice, immediately decided to nickname it the 'Flying Saucer'. The resolved circumstellar dust disk in the 'Flying Saucer' has a radius of about 300 Astronomical Units (45 billion km), or 5 times the size of the orbit of Neptune (assuming the same distance as the Rho Ophiuchi star-forming cloud, 500 light-years).

Seven young stars in the Rho Ophiuchi star-forming region are known to display similar reflection nebulae surrounding a dark lane (suggesting the presence of a dusty disk), but these objects are all still deeply embedded in the dense cores of this dark cloud. They are mostly protostars with ages of about 100,000 years, surrounded by a remnant in falling envelope. From model calculations, the astronomers find that it is inclined only about 4° to the line of sight and therefore seen very nearly from the side. A lower limit to the total mass of the disk is about twice the mass of planet Jupiter, or 600-700 times the mass of the Earth. A study of the recorded (reflected) light from the optical to the near-infrared indicates that the central young solar-type star has a temperature of about 3000K and has 0.4 times the luminosity of our actual Sun.

On the other hand, astronomers think that the newly found object has an age of about 1 million years and is in a more evolved stage than those in the neighbouring Rho Ophiuchi star-forming region. The new disk is located at the periphery of the dark cloud and is much less obscured than the younger objects still embedded in the dense dark cloud nursery, thus allowing a much clearer view of the dust disk.

Future complementary high-resolution observations by the VLT adaptive optics camera NAOS-CONICA will help the astronomers to understand the origin of this puzzling phenomenon, and its possible link to the planet-forming mechanism. According to researchers the 'Flying Saucer' object presents astronomers with a striking portrait of our Solar System in its early infancy. With this object, Nature has provided them a perfect laboratory for the study of both dust and gas in young circumstellar disks, the raw material of planets.

Computer simulations predict that baby planets produce measurable structural changes in circumstellar disks, but such signs of the planet formation are far from the sensitivity and the spatial resolution of the actual antenna arrays. The detection of these features is the goal of ALMA, and there is no doubt that this 'planet nursery' object will be a prime target for this future array of antennas.

Dental Researchers Find Novel Peptide in Saliva that Kills Broad Range of Fungi and Bacteria

A small piece of protein from one end of a larger molecule found in human saliva has been shown in laboratory tests to have potent antimicrobial activity against several types of bacteria and fungi, some of which are resistant to current drugs. According to Libuse Bobek, Associate Professor of Oral Biology in the University at Buffalo School of Dental Medicine, USA and a senior scientist of the research team if these findings hold up in animal and human trials, the peptide, labeled MUC-7 20-mer, could form the basis for promising new drugs for treating a wide range of infections There is an increasing need for new antimicrobial agents, especially antifungals because there are only a handful of these drugs, they are used widely, and several fungal strains already have developed resistance. This is a particular problem for immuno-compromised patients, such as those with HIV/AIDS, organ transplant patients and chemotherapy patients.

This novel peptide, on which Bobek holds a provisional patent, has been shown in vitro to kill the fungal agents that cause the most common opportunistic infections that threaten these patients — candidiasis, cryptococcosis and aspergillosis — as well as several bacteria, including E. Coli and P. Gingivalis, which cause serious intestinal and oral infections, respectively, and S. Mutans, which causes dental caries. Moreover, stresses Bobek, the peptide is active (in vitro) at very low concentrations — 10 micrograms per millilitre — shows little or no toxicity to mammalian cells and low tendency to elicit resistance. According to her MUG-7 20-mer appears to be a very versatile agent, active at very low dosing, which works comparable to or better than current drugs. It has a different mechanism of action, but we don't know yet specifically what the mechanism is.

The researchers knew that the peptide causes changes in fungal cell-membrane potential; is intenalized into the cells, and most likely acts on a specific part of the sub-cellular machinery. With such potent antimicrobial potential in human saliva, why do people have oral infections? Because the protein segment, the peptide, rarely is present by itself and the large protein molecule from which it is derived doesn't have microbicidal activity, Bobek noted. The peptide Bobek and colleagues are working with currently is composed of 20 amino acids, but they have found that smaller forms of the peptide still are active in vitro and are experimenting with increasingly shorter pieces. The researchers think this naturally occurring agent has high therapeutic potential for treating microbial infections in general and drug; resistant fungal strains in particular. It also has potential as a component of artificial saliva for treating salivary dysfunctions that result in increased plaque formation, cavities, gum disease and fungal infections.

Tronomers Find Jupiter-like Weather on Brown Dwarfs

For the first time, researchers have observed planet-like weather acting as a major influence on objects outside our solar system. A team of scientists from NASA and the University of California, Los Angeles (UCLA), has found cloudy, stormy atmospheres on brown dwarfs, celestial bodies that are less massive than stars but those have more mass than giant planets like Jupiter. The discovery will give scientists better tools for interpreting atmospheres and weather on brown dwarfs or on planets around other stars.

According to Adam Burgasser, astronomer at UCLA and lead member of the study team, the best analogy to what we have witnessed on these objects are the storm patterns on Jupiter. But we suspect the weather on these more massive brown dwarfs makes the Great Red Spot look like a small squall. Jupiter's Great Red Spot is a massive storm more than 24,000 km across and with winds of up to 425 km per hour. Burgasser teamed up with planetary scientist Mark Marley, meteorologist Andrew Ackerman of NASA Ames Research Center in California's Silicon Valley, and other collaborators to propose how weather phenomena could account for puzzling observations of brown dwarfs.

Marley and his team had been thinking about what storms might do to the appearance of brown dwarfs and when Adam showed them the new data, it was found there was a pretty good fit. The team calculated that using a model with breaks or holes in the cloudy atmosphere solved the mysterious observations of cooling brown dwarfs.

It may be recalled that the 'Brown Dwarfs', are the recently observed members of the skies, and at best can be conceived as failed stars. Not massive enough to sustain the burning of hydrogen like stars, brown dwarfs go through cooling stages that scientists observe with infrared energy-detecting telescopes. They appear as a faint glow, like an ember from a fire that gives off both heat and light energy as it dims. Astronomers expected brown dwarfs, like most objects in the universe, to grow steadily fainter as they cool. However, new observations showed that during a relatively short phase brown dwarfs appear to get brighter as they cool. The explanation for this particular observation perhaps lies in the clouds.

At least 25,000 times fainter than the sun, brown dwarfs are still incredibly hot, with temperatures as high as 2,000 degrees kelvin. At such high temperatures, things like iron and sand occur as gases. As brown dwarfs cool, these gases condense in the atmosphere into liquid droplets to form clouds, similar to water clouds on Earth. As the brown dwarf cools further, there is a rapid clearing of the clouds caused by atmospheric weather patterns. As the clouds are whisked away by the storms, bright infrared light from the hotter atmosphere beneath the clouds escapes, accounting for the unusual brightening of the brown dwarfs.

The model developed by the group for the first time matches the characteristics of a very broad range of brown dwarfs, but only if cloud clearing is considered, asserts Burgasser. While many groups have hinted that cloud structures and weather phenomena should be present, the researchers believe that they have actually shown that weather is present and can be quite dramatic.

By using Earth's weather as a starting point, Ackerman helped the team work storms — that include wind, downdrafts and iron rain — into their calculations. Although astrophysicists needed some help understanding rain because it's not an important process in most stars, the researchers used observations and simulations of terrestrial clouds to estimate the effect of iron rain on the thickness of an iron cloud.

The team's study, it is envisaged will help researchers determine the makeup of atmospheres outside our solar system. According to Marley brown dwarfs have traditionally been studied like stars, but it's more of a continuum. Brown dwarfs are a training ground for scientists to learn how to interpret observations of planet-like objects around other stars. Astronomers are looking for the brown dwarfs that are even colder and have water clouds just like Earth. Once these are found, their discovery will enable astronomers to validate the present understanding about them.

Malaria Vaccine Trials Succeed

A vaccine against malaria has successfully completed its first human trials in The Gambia under the auspices of the British Medical Research Council (MRC) in collaboration with a pharmaceutical company Glaxo Smith Kline. This initial success against *Plasmodium falciparum*, the most dangerous version of the malaria parasite, raises the prospect of producing an effective vaccine against the disease, which kills more than a million people every year.

The vaccine was tested on 306 men, half of whom received the malaria inoculation and half who were given rabies vaccine as a control. Administered in three injections with boosters given one and five months after the initial job, scientists claim it offered up to 47 per cent protection against the most virulent form of malaria.

The vaccinated group had 71 per cent fewer episodes of malaria than the controls, although the protection lasted only two months. It is hoped that further research will enable the vaccine to be refined to provide an even greater defence against the malaria parasite.

Known as RTS,S the vaccine marshals an immune response against malarial sporozoites, the spindly form of the parasite that mosquitoes inject into the bloodstream while they bite a person and the parasite lodges itself in the liver of the victim. Scientists at the Walter Read Laboratory in The Gambia where the trial was carried out, hope to incorporate another component in the vaccine enabling it to attack the next stage in the parasite's life — the production of seed-like merozoites. They propagate from the mature sporozoite, bursting out of the liver into the bloodstream in tens of thousands, colonising and destroying the infected person's red blood cells.

Malaria is found in 101 countries inhabited by 40 per cent of the world's population. It is caused by four parasitic micro-organisms: *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium* '*malariae* and *Plasmodium falciparum* which is the most virulent.

Preventive measures against malaria include the use of mosquito nets and the spraying of insecticides. Usually quinine derivatives are used as drugs once malaria is contracted although drug resistance is now becoming a great problem.
(*Source*: Spectrum Online)

Eleven More Moons of Jupiter Discovered

It has now been discovered that Jupiter has 11 more moons than astronomers once thought, bringing the known total for the giant planet to 39. This makes Jupiter, the planet having maximum number of moons in our solar system.

The newly discovered moons, or satellites as referred to by the astronomers, are not only quite small in size but are also located far away from the planet. The orbits of these satellites are having high eccentricity In spite of these factors, they are considered to be the satellites of the planet, according to the researchers.

Astronomers at the University of Hawaii, USA, using the Canada-France-Hawaii telescope and one of the largest digital imaging cameras in the world, detected the new satellites in December 2001. Digital images were processed with high-speed computers, and those that were likely to be a satellites were watched during the next few months to confirm their orbits and to reject asteroids masquerading as moons.

All 11 new moons are considered irregular satellites. They all have retrograde orbits, meaning they go around Jupiter in the opposite direction to the planet's rotation. They have long, elliptical orbits, which suggest Jupiter captured them when the big planet was young, perhaps in the first million years of the solar system's existence. They are all quite small, with diameters between 2 km and 4 km. At present, nothing is known about what they are made of, how dense they are or what their surfaces are like, but scientists presume they are asteroid-like space rocks.

Among Jupiter's 39 known satellites, 31 are irregulars. The eight regular satellites consist of four large moons and four smaller ones. Jupiter's nearest rival for having the largest number of known satellites is Saturn, that has a total of 30 satellites

Infections Do Not Protect Against Allergy

Traditionally it is believed that children, who suffer from certain infections at an early age, are protected against some other ailments all through their lives Some such early childhood infections are measles, chicken pox and mumps. However, according a study conducted by a team of Danish doctors these early childhood infections do not protect youngsters from developing allergies

In a study that contradicts earlier research suggesting common childhood illnesses could help to prevent allergies and asthma later in life, scientists at the Danish Epidemiology Science Center in Copenhagen have found that on the contrary they may increase the risk.

According to Professor Mads Melbye, the findings of their study do not support the suggestion that childhood infection with measles, rubella, varicella (chicken pox) or mumps protects against atopy (allergy), even if acquired early in life. The researchers compared the medical records of 889 Danish women to see if they had suffered from the infections before the age of seven and their results from standard tests for 11 common allergens such as domestic animals, grass and dust mites. They found women who had measles in their first year of life had a higher risk of allergy than those who did not have measles before the age of seven. The researchers further found that the risk of atopy increased significantly with increasing number of childhood infections in the first two years of life.

Some scientists had suspected that being exposed to many infections early in life could boost the immune systems and increase resistance to allergies.

Old and New Cures for Snakebite

Snakebite remains a frequent and potentially fatal occurrence in many parts of the world. Research teams at three universities in the United Kingdom are helping to identify the particular venom, which has been injected by a snake, investigating the real value of various traditional treatments and developing new anti-venom treatments based on DNA immunization.

According to Dr Robert Harrison of the Liverpool School of Tropical Medicine, in northwest England, conventional anti-venom treatments use relatively crude preparations, which lead to the production of many antibodies against non-toxic as well as toxic molecules in snake venom. The researchers hope to make something much more specific.

Anti-venoms for the treatment of snakebite are made today using an age-old technique in which animals, usually horses are injected with venom to cause an antibody-mediated immune response. The antibodies are extracted from the horse's blood serum and purified. This technique is too expensive besides the treatment can cause serious side effects

The fresh approach being developed by Dr Harrison with David Theakston and Gavin Laing uses DNA (deoxyribonucleic acid) vaccination. In this method, fragments of DNA from snake genes for venom molecules are made into vaccines and injected into the person who has been bitten. The consequence is that the patient's own body produces fragments of toxin-type proteins. These stimulate the patient's immune system to neutralise identical toxic proteins, which were injected into the body by the snakebite.

Preliminary tests of this approach, using DNA from Brazilian pit-viper venom to immunise mice, have given encouraging results. The immunised mice responded by producing potent anti-venom antibodies, which in this first experimental trial of the technique, were already nearly as effective as serums made using whole venom in neutralizing snake venom.

The research team at Liverpool is now going on to extend the DNA immunization approach to the carpet viper. This species is responsible for more deaths than any other type of poisonous snake in the world.

Meanwhile, Professor Isaac Asuzu of the University of Nigeria, in Enugu state, and Professor Alan Harvey, of Strathclyde University in Glasgow, Scotland, have been taking a closer look at some of the traditional plant remedies used by healers in Nigeria. The main aim of their research is to identify what elements in different such remedies are effective. It may then be possible to identify and isolate a few simple chemicals, which might then be used more effectively in isolation in therapy for snakebite.

With the collaboration of traditional healers, Professor Asuzu obtained samples from 10 plants used traditionally to treat three different Nigerian venoms, from the naja, echis and bitis snakes. According to Professor Harvey four out of the 10 look promising in terms of preventing or reversing some of the toxic effects of these snake bites. Analytical techniques are now being used to isolate the molecules in the plants, which are responsible for their beneficial activity. Professor Asuzu proposes to set up a tissue culture laboratory in his own department in the University of Nigeria with grants he is expecting various sources. There he will investigate more traditional plant remedies while continuing to identify and analyze the active molecules involved in collaboration with the team at Strathclyde University.

A third UK research team led by Professor Roger Thorpe at the University of Wales Bangor,UK has been investigating the genetics of pit vipers. The research group is trying to tackle the problem that arises due to the fact that although one green pit viper looks just like another, yet their venom can differ greatly. It is therefore an essential condition for anyone responsible for snake bite therapy to know which type of snakes live where, so they can have an appropriate antidote at hand in case of a snake bite. The knowledge about the type of viper and an appropriate antidote could make the difference between life and death in much of subtropical Asia. With this end in mind, Professor Thorpe and his colleague, Anita Malhotra, have been unravelling the complex family relationships between the members of the large group of Asian pit vipers. They now have 600 tissue and venom samples and know exactly from where each specimen comes.

Ultimately, this continuing work will help to make it possible for doctors to have the best possible anti-venom or DNA vaccine available to treat a common and dangerous form of snake bite, wherever it occurs.

Keeping Blood Pressure Down

Hypertension is one of the main contributors to coronary heart disease. With one in three men and one in four women dying from this disease in the western world, it is one of the biggest causes of death. A novel form of communication in the brain involving signalling from blood-borne hormones to brain cells that control blood pressure has been discovered by scientists.

Professor Paton and his team, in conjunction with the British Heart Foundation, the Wellcome Trust and the Royal Society, are discovering novel forms of communication between blood-borne substances, such as hormones and brain cells, and developing novel molecular tools to guide researchers in finding and imaging the brain cells that control blood pressure.

In a healthy human this pressure is monitored by sensors in the body (baroreceptors), which are located in the main blood vessels. The baroreceptors send signals to the brain stem and activate specific groups of brain cells. These cause an appropriate reflex response that returns the blood pressure to its normal level

In the most common form of hypertension, the cells that receive blood pressure level information (and control the nerves that supply the heart and blood vessels) faill to respond to incoming information from the blood pressure sensor. In these patients a hormone — angiotensin-two — has been found to have an increased activity. Hormones in the blood, such as angiotensin two, cannot normally affect brain activity because of the blood brain barrier (BBB).

But the team has discovered that blood-borne angiotensin-two can affect the electrical activity of brain cells that regulate arterial pressure. The hormone releases nitric oxide, a gas that freely diffuses across the blood vessel wall (the BBB) and stimulates inhibitory messages to brain cells that control blood pressure. These cells are then rendered incapable of responding to baroreceptor signals and blood pressure rises.

(*Source*: Spectrum Online)

Artificial Hand with 'Intelligence'

Two United Kingdom cybernetic engineers who have spent years devising the mechanical replacement to develop a prosthesis that looks and behaves as a human hand have devised a lightweight 'intelligent hand'. The principle behind the device — by Peter Kyberd of Oxford's Orthopaedic Engineering Centre and Southampton University' s Dr Paul Chapel — is to use microprocessors to undertake the functions that control the fingers, while the user gives only overall commands to open, close and hold objects, using simple signals.

The prosthetic fingers curl continuously from open to closed position just like the natural hand while the thumb also follows exactly the same movement. Each finger has force and slip sensors in its tip. If the object being held slips, this generates vibrations that are detected by the sensors and the hand automatically tightens its grip until the sliding stops. The sensors are sensitive enough for the hand to pick up and hold an egg. The controller circuit board is housed in the hand, which is covered by a silicone glove cast from a real hand.

Some such artificial hands are already being used by patients at Oxford's 'Limb Centre. One device is a hybrid hand complete with a wrist and elbow produced by the Bio-engineering unit of Edinburgh's Prince Margaret Rose Hospital. The device uses the same networking systems whose applications were originally pioneered by David Gow, Director of the Cybernetics Department of the hospital. With the arm, the master controller coordinates the actions of the joints in response to simple instructions from the wearer. The artificial arm is expected to be commercially available by 2003

(*Source*. Spectrum Online)

Chandra X-Ray Observatory Detects First Possible Evidence of Gravity's Effect on Neutron Star's Radiation

The data collected with NASA's Chandra X-ray Space Observatory through observations of a neutron star in the centre of a supernova remnant about 7000 light years away from earth, a team of astronomers led by George Pavlov of Penn State University in University Park, have detected features that may be the first direct evidence of the effect of gravity on radiation from a neutron star. This finding, if confirmed, could enable scientists to measure the gravitational field of neutron stars and determine whether they contain exotic forms of matter not seen on the Earth.

Pavlov and his colleagues observed the neutron star 1E 1027 with Chandra's Advanced CCD Imaging Spectrometer twice in January 2000, each time for approximately 30,000 seconds. The Pavlov's group analyzed the data collected by them and found two dips, or absorption features, in the spectrum of X-rays from the star. If these dips are due to the absorption of X-rays near the star by helium ions in a strong magnetic field, they indicate that the gravitational field reduces the energies of X-rays escaping from near the surface of a neutron star. According to Pavlov this interpretation is consistent with the data, but the features may be a blend of many other features. More precise measurements, preferably with Chandra's grating spectrometer, are needed. These absorption features may be the first evidence of the effect of gravity on radiation near the surface of an isolated neutron star. This is particularly important because it would allow astronomer to set limits on the type of matter that comprises this star.

Neutron stars are formed when a massive star runs out of fuel and its core collapses. A supernova explosion occurs and the collapsed core is compressed to a hot object about 19 km in diameter, with a thin atmosphere of hydrogen and possibly heavier ions in a gravitational field 100 billion times as strong as Earth's. These objects which have a density of more than 1 billion tons per teaspoonful, are called neutron stars because they have been thought to be composed mostly of neutrons. Although neutron stars have been studied extensively for more than three decades, their exact nature is still unknown.

According to Divas Sanwal, also of Penn State, scientists are not even sure that neutron stars are composed of neutrons. They could be largely composed of subatomic particles called pions or kaons, or even free quarks. One key to narrow the range of possibilities is to measure the strength of gravity on the surface of a neutron star by observing its effect on X-rays from very near the surface of the star. According to Einstein's theory of General Relativity, attraction of photons by a star's gravitational field results in a lower energy of the photon (longer wavelength of radiation) when detected by a distant observer. The measurement of this gravitational redshift relates the mass to the radius of the star, and it will test the theories for the various possible forms of dense matter.

The team, which also includes Slava Zavlin of Max Plank Institute for Extraterrestrial Physics, Germany, and Marcus Teter of Penn State, considered several possible explanations for the absorption features observed from 1E 1207. The strength and X-ray energy of the features make it improbable that they are due to intervening interstellar material or absorption due to electrons or ions circling in a strong magnetic field. The most likely hypothesis, they conclude, is that the features are due to absorption by helium ions in a magnetic field about a hundred trillion times more intense than the Earth's magnetic field. In this case, the gravitational redshift reduces the energy of the X-rays by 17 per cent.

Researchers Check Brain Waves to Predict Effectiveness of Antidepressants

A new study shows for the first time that measurable changes in the front of the brain can predict the effectiveness of an antidepressant within days of treatment— weeks before a patient begins to feel better

Using quantitative EEG, a non-invasive computerized measurement of brain wave patterns, the researchers discovered that specific changes in brain-wave activity precede clinical changes brought on by medication. The new findings, could lead to treatment programmes that help depression patients feel better faster by cutting evaluation periods from weeks to days. The findings also could aid in the development of new medications.

According to Dr Lan A. Cook, a lead member of the research team, up to 40 per cent of depressed patients do not respond to the first medication they try. Since it takes several weeks for an effective treatment to produce clear improvement, doctors often wait six to twelve weeks to decide that a particular medication just isn't right for that patient and move on to another treatment. By comparing EEG measurements before treatment with those soon after treatment begins, doctors may be able to evaluate the usefulness of an antidepressant within days rather than having to wait weeks to months. This technique also could slash the time and costs needed to develop and research new anti-depressants.

The study examined 51 adult patients diagnosed with acute depression. Each participated in one of two, double-blind, randomized treatment trials. One group received the antidepressant fluoxetine or placebo The other received the antidepressant venlafaxine or placebo (A placebo is an inactive substance, such as a sugar pill) Each subject received a quantitative EEG prior to treatment, 48 hours after treatment and one week after treatment.

Thirteen out of 25 subjects, or 52 per cent, responded to medication. Ten out of 26 subjects, or 38 per cent, responded to placebo. Subjects who responded to medication uniquely showed significant decreases in cordance, a measure of brain-wave activity, at 48 hours and one week cordance, a measure of brain-wave activity, at 48 hours and one week. Clinical changes did not begin to emerge until after four weeks. Subjects with the greatest changes in cordance had the most complete response to the medication after eight weeks. Comparing their findings with those of earlier studies in this field, Dr Cook, an assistant professor in the Department of Psychiatry and Bio-behavioural Sciences at the David Geffen School of Medicine at UCLA, USA said that other researchers have compared brain scans of depressed people before and after treatment and found differences between those who recovered and those who did not respond. Those findings, however, do not allow prediction of whether a particular patient is likely to get well. This is the first study to detect specific changes in brain wave activity that precedes the clinical changes in a way that can usefully predict response.

Cook's group proposes to continue their work to determine whether this same pattern holds for other antidepressant medications. They are also working to simplify the EEG method to make it easier for doctors to use this approach in patient care. Placing recording electrodes on the scalp performs EEG measurements. The electrodes connect to the body through conductive paste or gel, which is easily rinsed from a person's hair after the test is complete. It does not hurt and involves no radioactivity. The electrodes are connected to a computer, which measures the signals coming from the brain and processes them into colourful patterns.

Brain Damage Could Make You Act on Impulse

A new research study conducted by Rudolf Cardinal and his colleagues at the University of Cambridge suggests that those people who cannot resist acting on impulse may have damage to a small part of the brain involved in making choices. According to the researchers their findings suggest a mechanism by which nucleus accumbens dysfunction may contribute to addiction, attention deficit hyperactivity disorder (ADHD) and other impulse control disorders. Normally, a balance is struck between giving in to instant gratification and waiting for delayed rewards. But some individuals, including drug addicts and those suffering from attention deficit hyperactivity disorder (ADHD), cannot control their urge to have "it now".

Scientists found that a small neural region called the nucleus accumbens, buried deep in the brain, may hold the key to this behaviour. In laboratory experiments, trained rats with surgical lessions to the nucleus accumbens could not help acting on impulse when faced with the choice between an immediate small food reward or a more generous one later. Rather than wait for a better meal, they ate what was offered to them first. Before undergoing surgery the rats behaved in a very different way. Unitl the delay became great enough to defeat their memories, they chose to hold out for the larger reward

(*Courtesy*: Spectrum Online)

Compiled and Edited by
R. Joshi

Book Reviews

About Scientists and Inventors

The Little About Scientists
and Inventors All Should Know
Dilip M. Salwi
Publisher: Rupa & Co.
7/16, Ansari Road, Daryaganj
New Delhi 110 002
Pp. 86, Rs 50.00

Children as well as laymen are often keen to know about scientists and inventors. However, details about them and their work are generally available in the form of lengthy biographies. There are very few books available in the market which provide capsulised information about the important contributions made by the scientists and inventors and interesting details about their lives. The book under review written by the well-known popular science writer Dilip M. Salwi would be able to fill this gap by providing interesting information about, and achievements made by some important scientists and inventors.

The book includes biographical sketches of some 100 scientists and inventors everybody should know. Along with their contributions the book provides, in a nutshell, interesting details of their lives which may indeed prove inspiring for the young readers.

These days every other student wants to become either an engineer or a doctor. This is primarily the reason why the number of students opting for the science courses has been gradually declining over the years in higher classes. But, the biographical sketches of many scientists and inventors would make us believe that some of them were not initially interested in science. Influenced by their teachers or circumstances they later got inducted into science. Take, for instance, the case of Wilhelm Konrad Roentgen, the discoverer of X-rays. Trained as an engineer, he, influenced by his teacher, later on got interested in Physics. Incidentally, Roentgen was the person who got the first Nobel Prize for Physics in 1901. Surprisingly, Roentgen never patented his invention to earn money out of it. It is rather sad that this great scientist had to die in utter poverty due to Germany going through a period of economic crisis.

The life history of Edward Jenner, the British physician who discovered smallpox vaccination, is no less inspiring. The amazing fact about Jenner is that he never attended any college to learn medicine and surgery. In fact, before starting practice as a doctor in his own native village, Jenner worked as an appentice to a skillful surgeon.

The discoverer of electron, Joseph John Thomson, wanted to become an engineer. Thomson had to struggle hard in his childhood due to the poverty of his family as his father was a bookseller. Later, when the time came to opt for engineering his father passed away. Opting for science he became a scientist and was later made the Director of the premier research institution, Cavendish Laboratory.

Aleesandro Volta, the inventor of battery, was born in an aristocratic family. Although as a child he appeared to be mentally retarded later he outsmarted the boys of his age, Experiments in electricity became his passion. When he was hardly fourteen, he decided to become a physicist — something the modern young generation should take inspiration from.

Charles Darwin, the British naturalist and the author of *The Origin of Species*, was born into a family of well-known doctors. However, Darwin himself was not interested in medicine, nor was he interested in studies. His only interest was in watching birds and animals. His father was so much disillusioned with him that he thought that he would bring disgrace to the family. But, as everybody knows, he later on came out with his famous theory of evolution of life. Lives of great scientists and inventors remind us that one does not become great or famous overnight. It needs lot of dedicated and concerted effort and also perseverance to achieve excellence in any field of endeavour.

Some of the persons who later became eminent scientists or inventors came from families of humble background and meagre means. For instance, the inventor of motor car, Henry Ford, was the son of an agricultural worker. Michael Faraday, who made major discoveries in electricity and magnetism, had to work in a bookbinder's shop due to the poverty of his father. The inventors of aeroplane, the Wright brothers, were uneducated and worked in a cycle repair shop.

Konstantin E-Tsiolkovsky, who gave the basic principles of rocketry, was a classic case in himself. He was born in a remote village of Russia to a farm labourer with a huge family. Deaf due to an illness from childhood, Tsiolkovsky had to struggle hard throughout his life to study science. However, he somehow managed to become a science teacher in a village school and pursued science as a hobby. He started writing about his scientific studies in magazines. He wrote about the basic principles of rocketry in one such magazine. He also wrote a science fiction *Outside the Earth* to explain space travel to a common man The Russian scientific community was ultimately forced to recognise the talent of his village school teacher and Tsiolkovsky was made a national hero.

Like Tsiolkovsky, the British chemist John Dalton was also a school teacher. His scientific hobby was to study the weather. Out of his studies of weather Dalton propounded the atomic theory of matter, namely, that matter is made up of minute individual units called atoms.

It is said that career as a scientist has to begin at a very early age. But, there are many scientists who have proved this notion wrong. Perhaps one of the extreme examples is that of the British biochemist Frederick Gowland Hopkins, who discovered vitamins. His career as a scientist started very late when he was almost in his fifties. For his discovery, he received the Nobel Prize in medicine or physiology in 1929. At that time Hopkins was 68.

Copiously illustrated and with a glossary of technical terms in the end, the book has been written in simple language and in an easy-to-follow style. However, in 'A Note for Readers' the author has stated that he has selected "only those scientists and inventors everybody is keen to know about". Does he mean that people are not keen to know about some of the reputed Indian Scientists, such as, Homi J. Bhaba, P.C. Ray, S.S. Bhatnagar, Vikram A. Sarabhai, J.B.S. Haldane, Birbal Sahni, Salim Ali, S.K. Mitra and P.C. Mahalanobis? Failure to include the contribution and lives of these Indian scientists in the book is, in the reviewer's view, the greatest snag the book suffers from. Nevertheless, it will prove useful to children, teachers and laymen alike.

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The Excitement of Quizzing

Superkid Science Quiz and
Superchild Science Quiz
Dilip M. Salwi
Publisher: Rupa & Co.
7/16, Ansari Road, Daryaganj
New Delhi 110 002
Pp. 87 Rs 50.00

Quizzes not only test the knowledge and intelligence of a person but also judge his level of exposure and observation power, as also the interest taken by him in different fields of study. Quizzes have always been very popular with the children. However, of late, a renewed interest has been created, thanks in particular to the TV serials like *Kaun Banega Crorepati* and its clones.

Both the quiz books under review are meant for different age groups. While the book *Superkid Science Quiz* caters to the students between 6-10 years of age, the other book *Superchild Science Quiz* is meant for students in the age bracket of 11-13 years.

The first book contains, in all, 425 questions. The questions, by and large, are not only informative but are interesting and exciting too. Take, for instance, the following questions: How many muscles are required for smiling? Which bird has a crest on its head that it opens and shuts like a fan? Which planet is known as the 'morning star' as well as the 'evening star'? What are the dark areas on the Moon called? etc.

While the questions, on the whole, are good but some vague questions mar the quality of the book. Take, for example, the question (No. 311). What is the shape of a kite? The four options given are: (a) rectangle (b) eclipse (c) square (d) cube The author gives the answer as (e) with his clarificatory note "to be exact, quadrilateral." However, both the rectangle and the square fit into this description. Such questions should better be avoided or presented in a more precise form.

The question (No. 303) on the shape of pencil is vague too. While we encounter pencils of both cylindrical and hexagonal shapes, the answer given is cylindrical

In the question (No. 255) pertaining to the states of matter, the author has mentioned only four states in the answer. However, of late, a new state of matter, supposed to be the fifth state (called Bose-Einstein condensate) has also been discovered. To reviewer's mind, students up to 10 years of age should be told only about the three states of matter while the students of higher age group should be told about all the five states known to date.

In the quiz (No. 22) on plant eating animals, the options given are rhiniceros, racoon, bear and hyena. The answer given is rhinoceros while bear also fits into the description.

More such examples can be given. Under the Portrait Quiz (No. 420), against Einstein mass-energy relationship has been mentioned as his achievement while Einstein is more known for his *Theory of Relativity*. In the Quiz (No. 414) on the human body temperature, the unit 'Fahrenheit' is missing from all the four options.

The second book, *Superchild Science Quiz* contains, in all, 500 quizzes. Like the first book, this book too covers a wide gamut of topics in science. Some of the questions are indeed very exciting, e.g.,: Where is the 'ring of fire', a chain of volcanoes, located? Which planet in the solar system has polar caps? Which is considered to be the first science fiction novel written exclusively for young readers?

However, like the first quiz book, the second book also suffers from some pitfalls. Some technically wrong information has also gone in the framing of some questions. Take, for example, the question (No. 325): Of the following metals, which one is not noble? The options given are: mercury, copper, iron and silver. The author gives iron as the answer. But, mercury and copper are also not known to be noble metals. The correct framing should have been the following: Of the following metals, which one is a noble metal? The correct answer to this is, indisputably, silver.

The name of Tim Bernes-Lee appears in the answer to the question (No. 56): Who invented the internet? However, Tim Bernes-Lee only developed the hypertext language, known as HTML, which is used as a tool for surfing of the internet. It is not correct to say that Tim was the inventor of internet.

Under Portrait Quiz (No. 493) Carl Sagan's contribution has been quoted as making of the popular television serial 'Cosmos' However, Carl Sagan was more renowned for his research pertaining to the possibility of the existence of extra-terrestrial (EI) intelligence.

Both the books under review, notwithstanding the flaws/anomalies pointed out above, will be able to arouse the interest of young readers in science. Certainly the books will not only be able to judge how good a child is in science but also test his general knowledge in science

The good collection of questions appearing in the books will make a child more confident so that he is able to feel the excitement of quizzing in science.

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BOOK REVIEW 126

Use of Venn Diagrams in Teaching-Learning of Mathematics

G Ravindra
Regional Institute of Education (NCERT),
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MATHEMATICS plays a central role in Science and Technology. The *Numbers*, which are so fundamental to mathematics, encompass all disciplines of study and all walks of life. The Pythagoreans (around BC 540) literally worshipped the natural numbers and they believed that the entire Universe was made up of these numbers. Mahavira (850 AD) stressed the importance of *Ganita* (Mathematics) in all the three Worlds. But this subject of supreme importance also seems to pose insurmountable difficulties for a majority of the students.

Is Mathematics Difficult?

Several studies have observed that many of the students at school level, find mathematics a difficult subject and large number of students fail in this subject. Mathematics is difficult not because of abstraction, as has been generally perceived, but because of precision. Mathematics is difficult because unlike any other discipline, it demands complete precision (King, 1992). One of the vast areas of the world of contemplative beauty is mathematics and this alone is a sufficient reason for the study of mathematics. However, there is general perception that the inadequacies in teaching of mathematics have created the gap between the scientific community and the rest of the humanity, and thereby hampered the growth of our society Thus, there is a need for overcoming the inadequacies in teaching of Mathematics Any model of teaching of mathematics should ensure that mathematics is taught the way mathematics is and learnt the way mathematics is.

Teaching is a great art

Taking an active role in the learning process of the child is one of the greatest joys of teaching. Teachers have natural curiosity to observe how children grow and discover the world around them Teachers want to help and play an important role in facilitating their learning This is a tremendous job. One of the basic teaching functions is to "check for understanding" (Ronsenshine, 1983). Similarly, to "assess student comprehension" (Good & Grouws, 1979) as one of their instructional behaviours for effective mathematics teaching Shavelson (1979) argued that it is important for the teacher to estimate the "state of mind" of their students and that these estimates provide essential information for deciding what and how to teach.

The way mathematics is being taught is going through a dramatic change. The introduction to the study of "*Numbers and Numerations*" starts when the children begin to gather objects and then form groups or sets. Soon they need a way to describe the number of objects in the sets. To begin with, these descriptions are verbal—they count by saying the names of numbers as objects are singled out. Symbols for numbers are eventually introduced and then they learn to write numbers. It is imperative that children learn maths today by beginning with real-life problem of situation that needs to be solved. They are given freedom to use techniques that might be uniquely theirs. The premise is that children as well as teachers are most likely to remember the things that they grapple with and resolve. Today's, Mathematics curriculum is so different from what we were taught. What was emphasised then is not emphasised now. New names have been given to old procedures, and some procedures that took forever to master are no longer taught because a calculator can provide the answer at the push of a button.

The mathematics teacher, while developing the problem-solving ability among students, often follows two basic steps (Hayes, 1981): *problem representation* and *problem solving*. In the problem representation, a problem is converted from a series of words and numbers into an internal mental representation of the relevant terms. In problem solutions, operations are performed so as to deduce a solution to the problem from the internal mental representation.

Bertrand Russell (1917) rightly points out, "Mathematics is the study of assertions of the form 'p implies q', where p and q are each statements about objects that live in mathematical world". Thus, mathematics is a study of Sets where a set is identified with a '*precise property*', a property that is true or false, not both. But strangely the *Sets* do not find the right kind of importance in the teaching-learning process of mathematics in school education In the process of making mathematics more functional, the most fundamental element of mathematics— "*Set*", is not used properly as it should have been.

With these in mind, an attempt was made to study the Role of Venn Diagrams in Teaching and Learning of Mathematics.

Venn Diagram and its Importance

John Venn introduced Venn diagrams in 1880. A Venn diagram represents pictorial inter-relations among sets (well-defined properties), each of which is denoted by a closed region without holes. Though there are other diagrams like line diagram, directed graph, etc to illustrate relationships, Venn diagram has an advantage of *space* over the others.

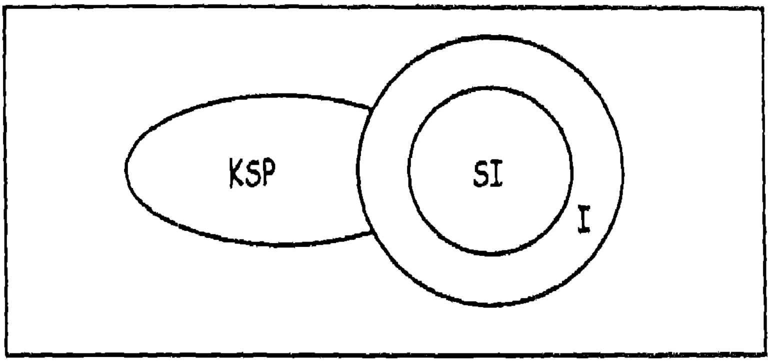
ANNEXURE-1

1. *Examples of the content selected for VDRA:*

   Find inter-relations (mathematical) among the following:
   (a) South Indians, Indians and Kannada speaking people
   (b) Similar triangles, congruent triangles, equilateral triangles, right-angled triangles, quadrilaterals and Polygons

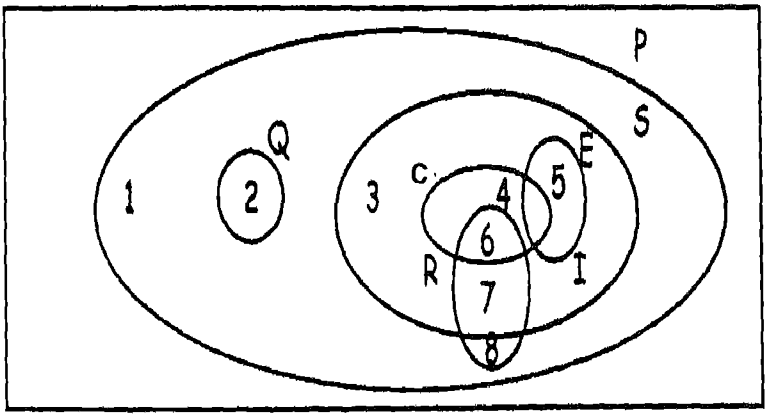
2. *VDRA expectations for (a) and (b)*

(a)



KSP - Kannada Speaking People SI - South Indians I- Indians

(b)



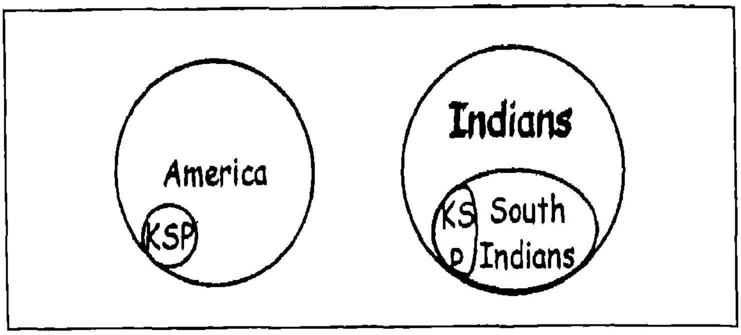
S - Similar triangles C- Congruent triangles E- Equilateral triangles R-Right-angle triangles
Q - Quadrilaterals P – Polygons

Note: Provide, to complete justification, one example for spaces (Gaps) 1, 2, 3, 4, 5, 6, 7, 8

3. *An example of creativity shown by the child of Grade V during Experiment - 2*

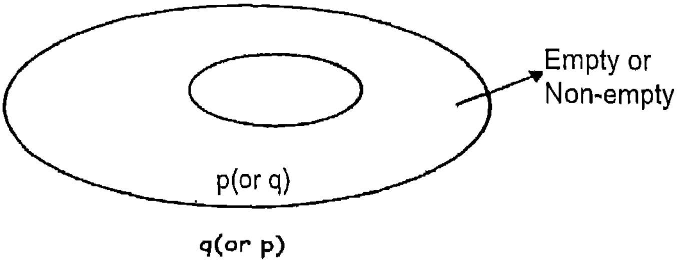
KSP - Kannada Speaking People, SI - South Indians, I - Indians

(C)



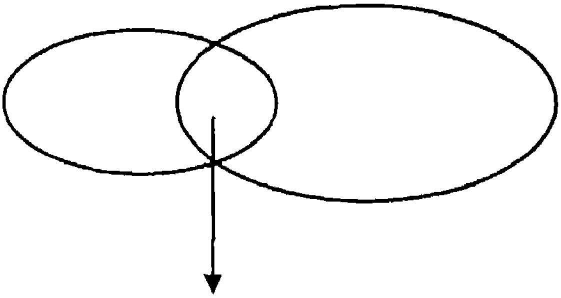
Given two well-defined properties p, q, the possible relations between them can be represented by Venn diagram in one of the following ways:

(a)



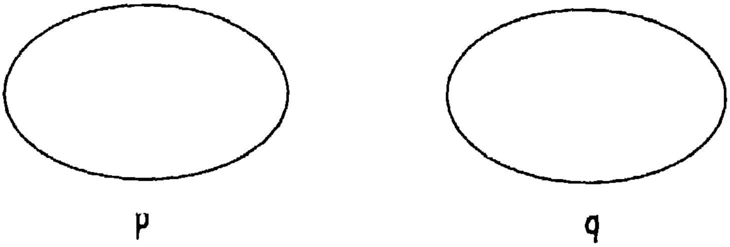
'p⇒q' or 'p is q' or 'p is part of q'

(b)



p and q (Which is non-empty)
some of p is q

(c)



No p is q

Rationale

The author, while teaching mathematics at different levels (graduates and post-graduates), gained adequate experience of Venn diagrams. This experience of more than two decades made him believe that Venn diagrams could best be employed in:

- *Better understanding of mathematics because of their visual effect;*
- *Providing clarity in teaching-learning of mathematics;*
- *Finding inter-relations among mathematical properties holistically and accurately and better analysis of the properties;*
- *"Conjecturing" as a consequence of natural creation of some new portion in Venn diagram (For Example: See Annex-1).* This Venn diagram motivated the author to conjecture C_1 and C_2. (See dotted lines in the diagram) and these conjectures are unsolved problems for more than two decades.

Keeping these observations in mind, the author tries to present the salient features of the *two simple studies* involving the *use of Venn Diagrammatic Approach (VDRA) in teaching-learning of Mathematics.*

Experiment 1

The purpose of the study was to determine the direct effect of Venn Diagrammatic Representation Approach training on student-teachers and to assess the impact of training to them. The training focussed on different components involved in Venn diagrams—like encoding of information, inferring and mapping the relationships before applying them to specific problem situations, establishing the emptiness or non-emptiness of a section of the Venn diagram. The author himself gave training during this period. Students were given frequent opportunities to practice and apply the related components in varied contexts.

The second session of the training programme was for the students to apply successfully the components involved in establishing the relationships A typical exercise given was — "Draw and Justify Venn Diagram of the ..., . , .. ". At the end, the author asked students "Is Venn diagram useful in teaching-learning of mathematics? If 'yes', why?" A summary of 110 responses received is given below. *All agreed that the Venn diagrams are useful in teaching-learning of mathematics.* The reasons given by them are:

- Venn diagrams are better tools for understanding because of their visual effect;
- Venn diagrams being pictorial representations, convey accurate meaning which words cannot (A picture is worth thousand words). The concepts explained through Venn diagrams are better retained for longer duration;
- Venn diagrams are self-explanatory; convey the meaning at a glance, have no language bias and easily understood by all types of students;
- Through Venn 'diagrams, abstract ideas are grasped easily and are kept at the concrete level of understanding;
- Relations between two or more concepts can be more easily and effectively learnt by Venn diagrams than by using symbols,
- Venn diagrams will reduce the verbal explanation of teachers and students and the school students feel happy to draw Venn diagrams;
- Venn diagrams help students to solve problems on sets more accurately and with better confidence and thereby reducing the mistakes/errors;
- Venn diagrams develop power of reasoning,
- With Venn diagrams, one can simultaneously inter-relate many properties;
- One can get new results from the basic elements of Venn diagram.

Experiment 2

The purpose of the experiment-2 was to investigate the questions raised in the experiment-1. Specifically, the investigation was designed to address the issues of influences of age and ability on direct effect of training. The training was administered in two sessions, focussing on the component processes involved in Venn diagram.

Lessons (related to maths and life—See examples in Annex-1) were taught to three different terminal groups (Grades V, X and XII) separately by author spending one hour per day for two days in case of X and XII and 40 minutes per day for three days for V Standard. V and X grade students did not have any idea of Venn diagrams earlier and the lessons to them included a brief introduction on Venn diagrams.

Sample

The sample for the studies were students of Regional institutes of Education (RIE), Bhopal and Mysore and Demonstration Multipurpose School (DMS) attached to RIE, Mysore. The samples particularly for Experiment-2 consisted of 33 fifth Grade students, 48 tenth Grade students and 21 twelfth Grade students from DMS and these students were new entrants. The data for the analysis came from the pre-test, post-test information and other information gathered during the intervention programme. These data were collected on separate occasions. The students age ranges from 10 years (Grade-V) to 20 years(Undergraduates)

Result

Though the author did not carry out a rigorous research, Restill felt it was worth sharing these with his fellow professionals Some of the experiences he had during the processes and different stages of experiments have been very briefly given

The t-values in the table given below clearly show that there is significant difference between the pre-test and post-test scores, implying that VDRA has definite influence on the performance of the students at all levels.

These data suggest that VDRA, in teaching of mathematics, offers a more positive view of students' learning than that through mere verbal statements.

Implications

For Textbook Writers

The findings of these studies give a clear direction for the textbook writers to include Venn Diagrammatic Representation Approach (VDRA) wherever they are appropriate and also to reduce the verbal statements by introducing Venn Diagrammatic Representations.

For Teachers

While transacting mathematical content, VDRA is quite helpful in making their ideas clear and also helps in vivid presentation of the content by reducing the verbal statements. It is necessary for them to focus on different components of VDRA (both separately and collectively) giving adequate opportunities for the students to make mathematical representations and think all plausible relationships while solving any of the mathematical problems.

For Students

The method helps in better understanding and also encourages to go for higher order thinking processes like conjecturing, problem solving, decision-making and creativity.

Grade	*Pre-test*		*Post-test*		*t*	*df*	*p*
	Mean	*SD*	*Mean*	*SD*			
V N = 33	2.61	1.68	5.81	2 44	7.62	32	0 00
X N = 48	3.40	2 31	5.71	3.48	5.32	47	0 00
XII N = 21	8.24	4.67	16.61	4.96	5.17	20	0 00

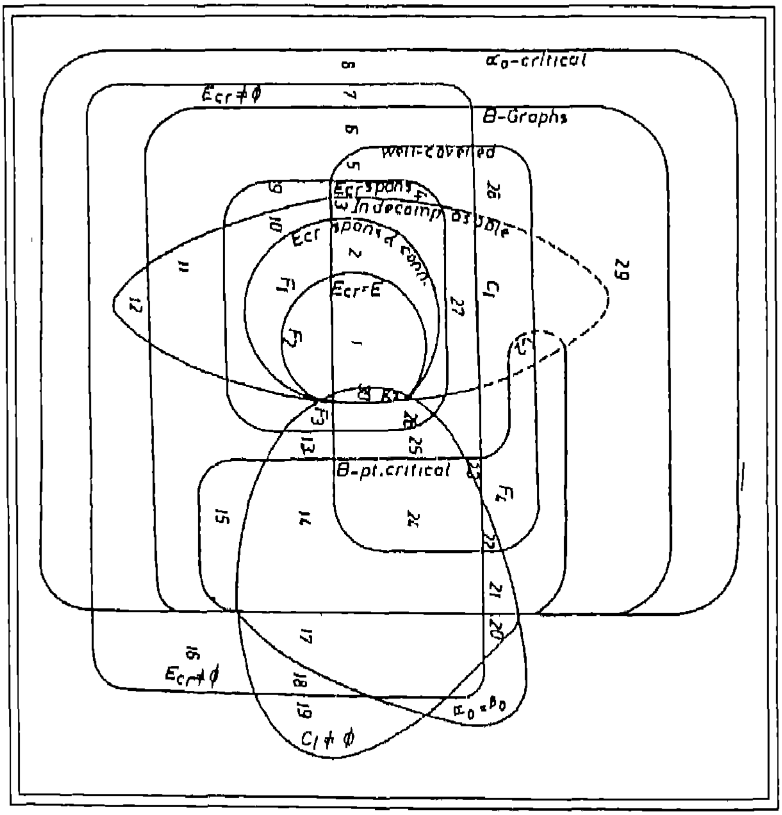
For Evaluators

From the point of view of the evaluator, the study suggests that marking and scoring is much more objective and easier because of a clear visibility of sections of Venn Diagram representing relationships.

Conclusion

Considering the vital role that Venn Diagrammatic Representation Approach (VDRA) plays in Mathematics learning, it can be effectively used in the classroom instruction.

ANNEXURE 2



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Living with Arthritis

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Arthritis, known as a common cause of disability affects almost one person in every family and actually refers to a group of over 100 different conditions. Osteoarthritis and rheumatoid arthritis (RA) are two commonest types of the diseases. These are not only found in humans but also throughout the animal kingdom. Some skeletons of pre-historic animals displayed in museum show signs of an arthritic condition. It is estimated that about one per cent of the global population suffers from one or the other types of arthritis affecting some of the 264 synovial joints present in the human system. Arthritis is the name given to a disease involving principally the joints and is characterized by pain, stiffness and swelling and finally, loss of function. In this disease the lining of the joints gets inflammed and can result in damage to its surface. The exact reason why the disease occurs is not known. Patients of arthritis may become so incapacitated that they are unable to perform even the most routine tasks. This incapacity combined with pain and deformity caused by disease and with enforced idleness and dependency often results in a sense of hopelessness and depression

Osteoarthritis is the most common form of arthritis Many factors which predispose the joint to osteoarthritic changes have been identified These include ageing, wear and tear, mechanical derangement in joint, obesity, haemophilia, crystal deposition, genetic and environmental It is an insidious, slowly advancing joint disorder commonly found in middle-aged and elderly individuals characterized by destruction of articular cartilage, overgrowth at joint margins and joint deformity which produce variable clinical disability of an affected joint It is not wholly due to ageing of cartilage but represents a disequilibrium and disorganisation of the process of degeneration and repair Osteoarthritis is called primary when no known predisposing factor is present. Secondary osteoarthritis is differentiated from primary in that there is a clearly defined underlying condition such as trauma, metabolic disease or inflammatory arthritis contributing to its cause.

Some of the changes which occur at joint during genesis of arthritis are now well-recognised. Degeneration of articular cartilage is the hallmark of osteoarthritis Degeneration involves softening of cartilage due to loss of mucopolysaccharide ground substance- 'chondroitin sulphate'. Superficial layers of cartilage, often not always in areas of stress become fragmented and fibrillated With joint motion, this fibrillated cartilage is lost thereby exposing underlying bone With the loss of full thickness of articular cartilage, characteristic changes take place in the underlying bone, i e., subchondral bone. The denuded bone is now exposed to the erosive action of opposing joint surfaces. The exposed bone becomes thickened in response to increased stress and frictional effects of joint motion which also produce a polishing effect giving a smooth ivory-like appearance to the bony surface This is known as 'eburnation'. The progressive loss of cartilage is often associated with proliferation of new bone and cartilage at the joint margins, resulting in spur formation These series of changes cause remodelling of bone. The clinical presentation of osteoarthritis can be divided into early and late stages. The early stages are dominated by pain on motion and stiffness, night pain and responsiveness to anti-inflammatory medication. The pain is an early symptom and results from distortion of joint capsule plus inflammatory infiltration of the capsular tissues and direct pressure upon exposed subchondral bone. Initial stiffness is probably the consequence of two roughened cartilage-bearing surfaces moving one on another The late stages are dominated by joint instability, predominance of pain at rest accentuated on weight bearing, and failure of responsiveness to anti-inflammatory agents. As this condition progresses, limitation of movement increases often more in one particular direction than another, resulting in fixed deformity It becomes difficult to sleep on the affected side. Gait disturbance of variable severity can also be observed.

Rheumatoid arthritis (RA) is the other commonest type of arthritis. It is a result of interaction of different set of factors. Although the disease is not genetically inherited, some inherited molecules on the surface of cells increase the likelihood of one getting the disease The disease is not contagious but a viral or bacterial infection can act as a trigger to start the disease process in susceptible individuals Once the process is triggered off, antibodies and immune cells that are made to defend against infection, turn against the body's own tissues and damage it. The brunt of the damage is borne by joints. Rheumatoid arthritis that starts before the age of 16 years is called juvenile rheumatoid arthritis. Women are more likely to get the disease as compared to men. Since the type of arthritis that occurs in RA may resemble the arthritis of several diseases, it may take a while before the diagnosis is settled. Most individuals with RA have an antibody called rheumatoid factor. It is important to realize that this is not found in every patient with RA and that it can occur in a small percentage of normal individuals and also patients with some other diseases

The diagnosis of arthritis is made on the basis of clinical presentation, X-rays and some blood tests. However, none of the conventional techniques for diagnosis of arthritis conclusively tell about the progression of the disease. Options such as CT and MRI scan will yield comprehensive information, but these diagnostic procedures are too expensive to be used routinely

Radionuclide imaging of the affected joint can yield information with respect to the extent of damage caused to the cartilage and bone by the intruding synovium. Painful joints are treated by non-surgical and surgical procedures. Non-surgical procedures include rest, physiotherapy, reduction in body weight, use of ambulatory aids and medicines. Rest is needed if the inflammation in joint is severe. However, if too much rest is given the joint may become stiff and muscles around them can become weak. With a right balance between rest and exercise, most patients can lead an active life. Ambulatory aids such as stick, walker or crutch avoid full weight bearing on the concerned joint and helps to alleviate symptoms of arthritis. In addition, use of shoe-raise to compensate for true or apparent shortening improves the gait of arthritic patient Immobilisation of the joint with traction in the acute inflammatory phase of arthritic process reduces strain on the joint. Utilisation of appropriate splints and braces are also recommended for the patients. Battery of analgesic/anti-inflammatory/anti-pyretic medicines are recommended for getting relief. These medicines slow down the progress of disease by their lysosomla-stabilizing and anti-prostaglandin effects on the articular carilage. Some of them bring about immunosuppression, immuno-stimulation and immunomodulation and decrease pain and swelling and improve joint mobility. Slow active anti-rheumatic or anti-rheumatic drugs act at a more basic level in the pathway that leads to disease and do not start working soon after they are administered. They act slowly taking from weeks to up to six months or so for their beneficial effects to appear But none of them arrest the progression of disease The treatment is economical but prolonged usage and frequent dose adjustments are required. Long term use of drugs is associated with side effects. Recently, several new medicines including monoclonal anti-bodies are being tried in patients with advanced disease In general, three indications for considering a surgical procedure include progressive and irreversible loss of joint functions, pain especially nocturnal pain and diminishing capacity to carry out activities of daily living independently. Surgical procedures include arthrodesis, arthroplasty, osteotomy, patelletomy and total joint replacement But the post-operative problems of immobilisation such as deep vein thrombosis, chest infection, urinary stasis and pressure sores are constant source of worry when surgical treatment of weight-bearing joint is undertaken.

Radiation synovectomy offers a viable and attractive alternative to surgical procedures for the effective management of arthritis. It involves intra-articular injection of a beta-emitting radionuclide of appropriate nuclear, chemical and biochemical characteristics, into the affected synovial joint to control the excessive proliferation of synoviocytes. For example, yttrium 90 for knee joint or rhenium 186 for shoulder, elbow, wrist and hip joint and erbium 169 for small joints such as metacarpophalangeal joint or tarsel joints. The mechanism of action is by beta-emission which destroys the infected hypertrophied synovium causing shrinkage of synovium thereby improving the painful condition and restricted movement of the joint. However, the radiation exposure to healthy organs due to radionuclide escaping from injected joint cavity was a matter of concern. The current approach is to make the particles of appropriate size and then label them with the radionuclide of choice thereby reducing their probability of escape from cavity. Development of colloidal particles such as silicates, citrates and hydroxyoxides of the isotope ^{90}Y and ^{169}Er has reduced the incidence of eakage from the joint.

Thanks to the modern research in he field of nuclear medicine for developing the new procedure called radiation synovectomy' for removing the nflammed lining of the joint without conventional surgery. Conventional surgery is expensive, needs hospitalisation and involves long convalescent period. Radiation synovectomy is cheap and does not equire any indoor admission. It has many other added advantages over surgical procedures, e.g., it is a minor ntervention, possible in inoperable patients, without side-effects, imultaneous treatment of multiple oints is feasible or at short intervals and epetition is possible Contradictions are children, pregnancy, destruction of articular cartilage and severe malrotation of knee joint Radiation synovectomy is invasive and relief generally lasts for three to four years. In case of recurrence, the treatment can be repeated The radiopharmaceutical division of BARC has taken up a programme for development of radio-synovectomy agents. The radio-isotopes of choice are the ones which can be easily produced in large quantities in medium flux reactor, e.g., Holmium 166 This isotope is prepared at Dhruva reactor and made available to large number of patients at reasonable rate. The biological evaluation of labelled holmium hydroxy-apatite particles (^{166}HO–HA) was done at Radiation Medicine Centre at Ruby Hall Clinic, Pune. Earlier, this centre has been practising radiation synovectomy using imported products The centre has demonstrated that the product from Dhruva reactor could be used as replacement for the expensive commercial synovectomy agents. The indigenous availability of this product for radiation synovectomy would be an important milestone and make this treatment more widely available at affordable cost to the needy patients of India. This product is earmarked for regular deployment on a large scale through the Board of Radiation and Isotope Technology (BRIT).

Efficacy of Markovnikov Rule – An Electronic Interpretation

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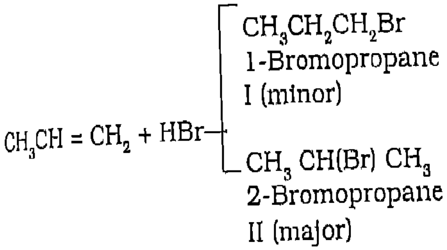
MOST of the discoveries and inventions in chemistry are the results of keen and minute observations. There is no dearth of discoveries which took place just as a matter of intuition but that also involved constant and continuous minute observations and search for reasons for the intuition Kekule[1] could invent the structure of benzene in 1865 only on the basis of the dream of a snake catching hold of its own tail and thus infusing in him the idea of a ring structure for benzene. Sometimes many experimental observations are unexpected and mind boggling In such cases, the generalisations dominate and take the form of a rule. The same happened with Markovnikov while studying the addition reactions of alkenes. The Russian chemist Vladimir Markovnikov carried out studies of the addition reactions of alkenes with different molecules. In case of ethene, ethyl iodide was obtained by addition of gaseous HI but the problem became a bit difficult when the reaction was studied with propane as two compounds—1-Iodopropane and 2-Iodopropane were expected and were actually obtained though in different proportions, the 2-Iodopropane being the major product Similarly, on carrying out the reaction with 2-methylpropene, 2-Iodo-2-methylpropane was obtained as the major product. Markovnikov examined the pattern of a large number of such reactions and formulated a rule in 1869. The rule was termed as *Markovnikov*[2] rule and can be stated as per its classical definition. However, with the development of reaction mechanisms Markovnikov's observations can be interpreted in terms of electronic factors like inducive, electrometric and hyperconjugative effects which lead to understanding by reasoning. Hence, an attempt has been made in this paper to interpret efficacy of MK rule in terms of electronic factors.

Classical Definition of Markovnikov (MK) Rule

The rule[2] states that "in the addition of an acid to the carbon-carbon double bond of an alkene, the hydrogen of the acid attaches itself to the carbon that already holds the greater number of hydrogens." According to Isenberg and Gridinic[3], the rule states that positive portion of the reagent goes to that side of the double or triple bond that has more hydrogens." Many authors also mention that negative part of the asymmetrical addendum while adding to the unsymmetrical substrate goes to that carbon atom which carries less number of hydrogen atoms. Besides the hydrogen halides, MK Rule also governs the addition of other unsymmetrical reagents like H_2O, H_2SO_4, HOCl, NOCl etc. to unsymmetrical alkenes and alkynes

The rule can be illustrated by taking the addition reaction of HBr to propene when compound numbers I and II are possible but the experimental observations are found in tune with the definition when compound II was obtained as a major product.



$$CH_3CH=CH_2 + HBr \rightarrow \begin{cases} CH_3CH_2CH_2Br \text{ 1-Bromopropane I (minor)} \\ CH_3\,CH(Br)\,CH_3 \text{ 2-Bromopropane II (major)} \end{cases}$$

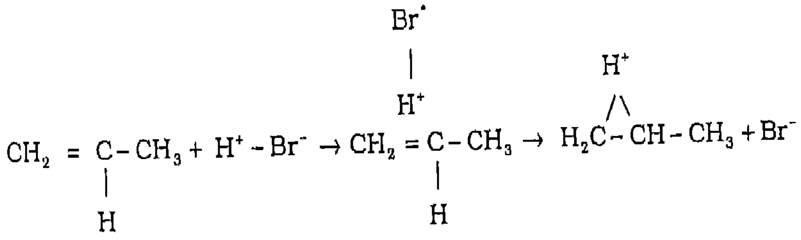
Electronic Explanation of MK Rule and its Extension

Formation of compound II as the major product can now be explained on the basis of electronic factors like inductive, electromeric and hyper-conjugative effects which can minimise the rote memory Electronic explanation of the rule is given below.

Addition of H-Br to propene is an example of electrophilic addition reaction. Propene being a good source of loosely held pie (π) electrons, is first attacked by H+ released from H-Br thus leading to the formation of the intermediate carbocation in the following steps:

Step (1) Formation of Pie Complex

H-Br gets attached to the olefinic site through the partially positively charged H atom to form the Pie (π) complex which is subsequently converted into the intermediate cyclic cation (III) as mentioned below.



$$CH_2=\underset{\underset{H}{|}}{C}-CH_3 + H^+-Br^- \rightarrow CH_2=\overset{\overset{\overset{Br^{\cdot}}{|}}{H^+}}{\underset{\underset{H}{|}}{C}}-CH_3 \rightarrow H_2C\overset{\overset{H^+}{/\backslash}}{-}CH-CH_3 + Br^-$$

Propene Pie Complex Cation (III)

Step (1)

Step 2

The cyclic cation (III) can give rise to two carbocations (IV) and (V) which on being attacked by the nucleophile (Br^-) can form two products (VI) and (VII) respectively·

$$CH_3-CH_2 - {}^{+}CH_2 \rightarrow CH_3 - CH_3-CH_2 \\ -CH_2Br$$

1° Carbocation 1-Bromophropane
IV (Less stable) VI (minor)

$H_2C = CH - CH_3,-$
III

$$\overset{Br^-}{CH_3-{}^{+}CH-C^{+}H_3 \rightarrow CH_3-CH\ (Br) -} \\ CH_3$$

2° carbocation 2-Bromopropane
V (More stable VII (major)

It is well known that stability of carbocations is in the order: 3°> 2°> 1° as discussed on page 17*. The secondary carbocation (V) being more stable leads to formation of 2-Bromopropane as the major product.

Addition Reactions of HBr with Alkynes

The rule can further be illustrated by taking the example of addition reactions with Alkynes. Now for simplicity sake, it can be assumed that ethyne adds with HBr in two steps— the first step being the attack of H^+ from HBr to form the carbocation VIII which is then attacked by Br^- to form vinyl bromide.

$$H-C \equiv C-H + H-Br \xrightarrow{H^+}$$

$$H_2C = C^{+}H \ \underline{Br}^{-} \ CH_2 = CHBr$$

VIII Vinyl bromide

Vinyl bromide gets resonance stabilised as shown below:

$$CH_2 = CH-\dot{B}r \Leftrightarrow \overline{C}H_2-CH = \dot{B}r^{+}$$

However, when further addition of H–Br takes place with vinyl bromide, 1, 1-dibromoethane is the expected product.

$$CH_2 = CH-Br + H^{+}-Br^{-} \xrightarrow{H^+}$$

$$CH_3-\overset{+}{C}H-Br \xrightarrow{Br^-} CH_3-CHBr_2$$

After understanding the mechanism of addition reaction of H-Br to ethyne, the single step addition reaction can be depicted as given in the box.

$$\boxed{CH \equiv CH + H^{+}Br^{-} \longrightarrow CH_2 = CHBr \xrightarrow{H^{+}-Br^{-}} CH_3-CHBr_2}$$

Similarly, addition of H-Br to propyne and 1-Butyne can be practised by students.

$$CH_3 - C \equiv C - H + H^{+}Br^{-} \longrightarrow$$

$$CH_3 - C(Br) = CH_2 \xrightarrow{H^{+}-Br^{-}} CH_3C(Br_2) - CH_3$$

$$CH_3 - CH_2 - C \equiv C - H + H^{+}Br^{-} \longrightarrow$$

$$CH_3CH_2 - C(Br) = C - H_2 \xrightarrow{H^{+}-Br^{-}}$$

$$CH_3CH_2C(Br_2) - CH_3$$

It may be remembered by the students here that the oppositely charged particles combine together to form the new covalent bond.

Once the electronic explanation is clear to the students they may be asked to practise addition reactions of various other unsymmetrical reagents to unsymmetrical subtracts like propene, propyne etc. It will be useful for the students to complete the following exercise indicating the major product.

Exercise - 1

Write the major product in the following reactions:

$CH_3-CH = CH_2 + H_2SO_4 \longrightarrow$

$+ H-CN \longrightarrow$

$+ HO^- - CL^+ \longrightarrow$

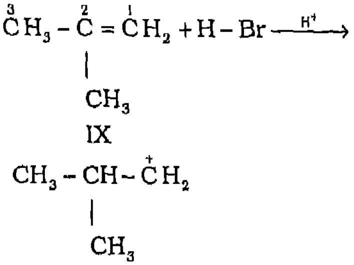
$+ O = N^+ - Cl^- \longrightarrow$

The similar exercise may be done with ethyne and propyne while keeping in mind that alkynes will undergo addition reaction with double the amount of addendum as compared to alkenes.

Stability and Rearrangement of Carbocations

As discussed earlier during addition reactions, the product formation is also decided by stability of the carbocation formed during the reaction. *The reaction proceeds in such a manner that it involves the more stable carbocation as the intermediate which may even involve rearrangement of carbocation.* Let's consider the addition reaction of HBr with 2-Methylpropene.

Electromeric effect in the substituted alkene in the presence of HBr involving migration of electrons from C_1 to C_2 will give rise to the unstable primary carbocation X as depicted below:

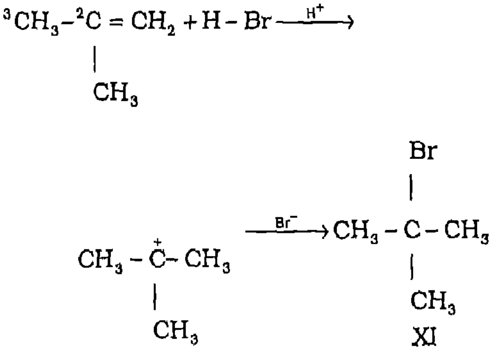


$$\overset{3}{C}H_3 - \underset{\underset{\text{IX}}{CH_3}}{\overset{2}{C}} = \overset{1}{C}H_2 + H-Br \xrightarrow{H^+}$$

$$CH_3 - \underset{CH_3}{CH} - \overset{+}{C}H_2$$

X 1° unstable carbonium ion

On the other hand, the electromeric effect in alkene from C_2 to C_1 will lead to the stable 3° carbocation which otherwise is also favourable due to the cumulative +I effect of the two methyl groups thus leading to the formation of 2-Bromo-2-methylpropene (XI). Markovnikov actually observed formation of this compound as the major product[4].

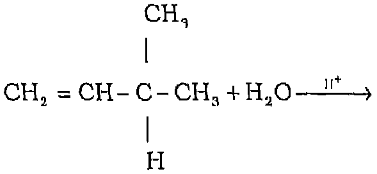


$$^3CH_3-{}^2\underset{CH_3}{C} = CH_2 + H-Br \xrightarrow{H^+}$$

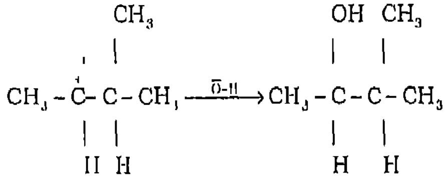
$$CH_3 - \underset{CH_3}{\overset{+}{C}} - CH_3 \xrightarrow{Br^-} CH_3 - \underset{\underset{\text{XI}}{CH_3}}{\overset{Br}{C}} - CH_3$$

3° carbocation (stable)

Sometimes inductive and electromeric effects alone are unable to explain the formation of the addition product. For example, hydration of 3-methyl-1-butene should lead to the formation of 3-methyl-2- butanol (XII) via the formation of the 2° carbocation as per MK Rule as well as on the basis of inductive and electromeric effects But XII is actually obtained as a minor product.



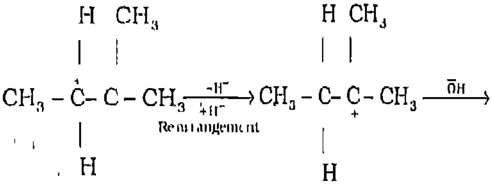
$CH_2{=}CH-\underset{H}{\overset{CH_3}{C}}-CH_3+H_2O\xrightarrow{H^+}$



$CH_3-\underset{H}{\overset{+}{C}}-\underset{H}{\overset{CH_3}{C}}-CH_3\xrightarrow{\bar{O}-H}CH_3-\underset{H}{\overset{OH}{C}}-\underset{H}{\overset{CH_3}{C}}-CH_3$

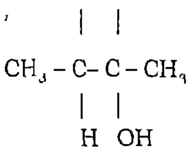
2° carbocation XII (minor)

In actual practice in this reaction, the major product[4] is found to be 2-methyl-2-butanol (XIII) which can be explained by the rearrangement of less stable 2° carbocation to the more stable 3° carbocation followed by attack of $\bar{O}-H$ thus leading to the formation of (XIII) as shown in the following sequence of reactions



$CH_3-\underset{H}{\overset{H}{\overset{+}{C}}}-\overset{CH_3}{C}-CH_3\xrightarrow[+H^-]{-H^-}CH_3-\overset{H}{C}-\underset{H}{\overset{CH_3}{\underset{+}{C}}}-CH_3\xrightarrow{\bar{O}H}$

2° carbocation less stable 3° carbocation more stable



$CH_3-\underset{H}{\overset{H}{C}}-\underset{OH}{\overset{CH_3}{C}}-CH_3$

XIII (major)

Extension of MK Rule

Thus Markovnikov rule can be extended by the statement that electrophilic addition to a carbon-carbon multiple bond involves the formation of a more stable carbocation as the intermediate.

Role of Hyperconjugation in Electrophilic Addition Reactions

We may come across many cases where MK rule fails to explain the formation of the major product as observed in the hydration reaction of 3-Methyl-1-butene when the alcohol formed is not in conformity with the MK rule. To cite another example, let's study the addition reaction of 2-pentene (XIV). In this case the two olefinic carbon atoms contain one H atom each. Hence, failure of the MK rule. In such a case, generally the role of inductive and electromeric effects is considered On the basis of greater inductive effect of $-C_2H_5$ group than the $-CH_3$ group, electromeric effect should take place from carbon 3 to carbon 2 leading to the formation of carbocation with the +ve charge at carbon 3 thus resulting in the formation of 3-chloropentane which, however, is not the major product. The major product[5] is actually 2-Chloropentane. This observation can be explained on the basis of hyperconjugation. *Hyperconjucation is delocalisation of the alpha C–H sigma electrons. Greater the number of alpha C–H sigma bonds, greater will be the hyperconjugation. In such a case when there is a competition between hyperconjugation and inductive effect, it is the hyperconjugation effect which dominates.* Hence in the addition reaction of HCl to 2-pentene, 2-Choloropentane (XV) is obtained as the major product via the formation of carbonium ion with +ve charge at carbon 2. These observations can be explained as per mechanism given below:

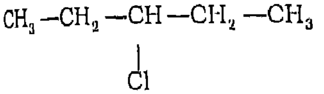
On the Basis of Inductive and Electromeric Effects

$\overset{5}{C}H_3-\overset{4}{C}H_2-\overset{3}{C}H=\overset{2}{C}H-\overset{1}{C}H_3 \xrightarrow{H^+}$

(XIV)

Four alpha C – H sigma bonds

(lesser hyperconjugation)



$CH_3-CH_2-\underset{\displaystyle Cl}{\underset{|}{C}H}-CH_2-CH_3$

3—Chloropentante (minor)

On the Basis of Hyperconjugation and Electromeric Effects

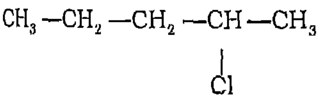
$\overset{5}{C}H_3-\overset{4}{C}H_2-\overset{3}{C}H=\overset{2}{C}H-\overset{1}{C}H_3 \xrightarrow{H^+}$

(XIV)

$CH_3-CH_2-\overset{\alpha}{C}H_2-\overset{+}{C}H-\overset{\alpha}{C}H_3 \xrightarrow{Cl^-}$

Five alpha C—H sigma bonds

(Greater hyperconjugation,



$CH_3-CH_2-CH_2-\underset{\displaystyle Cl}{\underset{|}{C}H}-CH_3$

2 — Chloropentance XV (major)

After understanding the role of hyperconjugation, students may be asked to predict major products of following addition reactions to strengthen this concept.

Exercise 2

Write the major addition product in the following reactions·

$CH_3-CH_2-CH_2-CH=CH-CH_3 + H-CN \rightarrow$

$+ H-Br \rightarrow$

$+ HOCl \rightarrow$

$+ NOCl \rightarrow$

Relative Reactivities of Alkenes and Substituted Alkenes

Besides explaining the formation of the major addition product, the electronic effects also help in predicting relative reactivities of olefins towards their electrophilic addition reactions. The electron releasing groups attached to the olefinic carbon atom increase reactivity because of increase of electron cloud density whereas the electron withdrawing groups decrease the reactivity. Hence, the order of reactivities of addition reactions of olefins is found in the following sequence:

$R_2C = CR'_2 > R_2C = CHR' > R_2C=CH_2 > RCH = CHR' > RCH = CH_2 > CH_2 = CH_2 > C_6H_5-CH = CH_2 > CH_2 = CH-X$

Exceptions to MK Rule

There are some olefinic compounds which show addition reactions contrary to MK rule. Such examples have already been discussed during the hydration of 3-Methyl-1-butene. Besides such examples, olefins containing strong electron withdrawing groups[6] like F, -CH, NO_2 substituted amines etc. may violate MK rule, which is explained below with the help of three examples

Example A: During the addition reaction of HI with $(CH_3)_3N^+CH=CH_2$,(XVI) 1-Iodo-2-trimethylammonium ethane ion (XIX) is obtained as the major product. This addition reaction is in contradiction to the MK rule and is accounted for by the fact that the intermediate carbocation (XVII) is more stable than (XVIII) in which the +ve charges lying on the adjacent N and C atoms destablise the carbocation, hence the formation of unexpected product (XIX).

$$(CH_3)_3N^+ - CH = CH_2 + HI \xrightarrow{H^+}$$

(XVI)

$$(CH_3)_3\overset{+}{N} - \overset{+}{C}H - CH_3$$

N – Ethenyl trimethyl amonium ion

XVII (unstable)

$$(CH_3)_3\overset{+}{N} - CH = CH_2 + HI \xrightarrow{H^+}$$

$$(CH_3)_3\overset{+}{N} - CH_2 - \overset{+}{C}H_2 \xrightarrow{I^-}$$

XVIII (more stable)

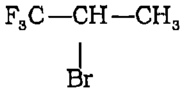
$$(CH_3)_3\overset{+}{N} - CH_2 - CH_2I$$

XIX (major)

Example B: 3,3,3-trifluoropropane while adding to HBr exhibits another interesting case which is again contrary to the MK rule. This is due to the most electronegative nature of fluorine atom (-I effect) that electrons shift towards carbon 2 and not carbon I resulting in the formation of 3-bromo-1 1, 1-trifluoropropane (XXI) on addition of H-Br as the major product. However, small amount of 2-bromo-1,1,1-trifluoropropane is also obtained as a minor product which otherwise is in consonance with the MK rule.

$$\text{(i)}\quad F_3\overset{3}{C} - \overset{2}{C}H = \overset{1}{C}H_2 + \overset{+}{H} - B\overset{-}{r} \xrightarrow{\text{As per MK rule}}$$

(XX)



$$F_3C - \underset{\displaystyle Br}{\underset{|}{C}H} - CH_3$$

(minor)

$$\text{(ii)}\quad F_3\overset{3}{C} - \overset{2}{C}H - \overset{1}{C}H_2 + \overset{+}{H} - B\overset{-}{r} \xrightarrow{H^+}$$

(XXI)

$$F_3C - CH_2 - CH_2 \xrightarrow{Br^-} F_3CCH_2 - CH_2 -$$

3 – Bromo, 1,1,1,-trifluoropropane (major)

However, in substituted alkenes of the type Y—CH=CH_2 where Y is some more electronegative atom or group and having a lone pair of electrons i.e., this group is directly attached to the olefinic carbon, we come across an interesting situation where the product is also not in consonance with the -I effect of the more electronegative atom/group like F, Cl, R – O etc In such a case, the electron attracting power of substituents of this type seems more than counterbalanced by stabilisation of the carbocation produced due to the ability of the substituents to donate their unshared electrons to the adjacent +vely charged carbon as illustrated below:

$$F - CH = CH_2 \xrightarrow{H^+} F - \overset{+}{C}H - CH_3 \xrightarrow{X^-}$$

$$F - CH(X) - CH_3$$

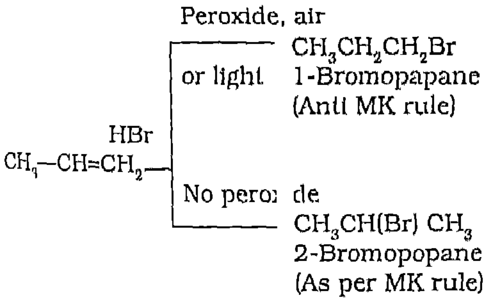
It may be emphasised here that in such a case the electron attracting and electron donating effects operate in opposite directions but the stabilising effect produced by the unshared electrons seems to be the dominating factor in deciding direction of addition.

Example C: Similarly, allyl alcohol adds to HBr but the addition takes place contrary to MK rule as given above in B (ii). This is due to the presence of hydroxyl group which exerts strong inductive effect

$CH_2 = CH{-}CH_2{-}OH + HBr \rightarrow$
Allyl alcohol
$CH_2(Br)\ CH_2CH_2OH$
3-Bromo-1-propanol

Anti-Markovnikov Rule (Kharasch Effect)

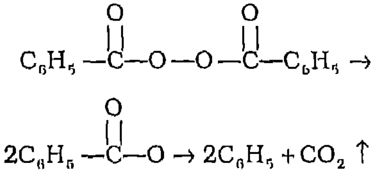
Kharasch and Mayo (1933) observed that addition of H-Br to an unsymmetrical alkene in presence of air, peroxide or light yields predominantly the product[7] contrary to MK rule. This phenomenon is known as 'peroxide effect' but does not apply to additions involving HCl, HI, H_2SO_4, H_2O etc., This point can be illustrated by considering the addition reaction of HBr to propene when 1-Bromopropane is obtained as the major product in the presence of air and peroxide as given below:



This is due to the formation of free radicals during addition reactions. In the presence of peroxides, the addition takes place via free radical mechanism rather than ionic mechanism. The reaction is supposed to proceed via three well known steps of initiation, propagation and termination.

Initiation

Since peroxides are relatively unstable compounds, they undergo thermal or photochemical decomposition to produce alkoxy radicals (RO) which then attack HBr to form Bromine free radical:



$$C_6H_5{-}\overset{O}{\overset{\|}{C}}{-}O{-}O{-}\overset{O}{\overset{\|}{C}}{-}C_6H_5 \rightarrow$$

$$2C_6H_5{-}\overset{O}{\overset{\|}{C}}{-}O \rightarrow 2C_6H_5 + CO_2 \uparrow$$

$C_6H_5 + H{-}Br \rightarrow C_6H_6 + Br$(Free radical)

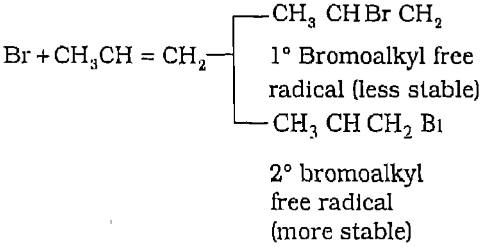
During photochemical addition, the Bromine free radical is supposed to be produced in presence of light by homolysis of HBr

$$H{-}Br \xrightarrow{E=h\nu} H + Br$$

Propagation

Bromine radical produced thermolytically or photolytically adds to either of the two carbon atoms of double bond to produce bromoalkyl free radical The bromoalkyl free radical may be primary or secondary. The preferential formation of primary or secondary free radical depends on the stability pattern (3°>2°>1°). The secondary bromoalkyl free radical being more stable than the primary one, it is obtained preferentially.

This secondary free radical then reacts with another molecule of HBr to form the anti MK product along with the formation of another free radical continues thus resulting in propagation of the reaction



$Br + CH_3CH = CH_2 \to$

$CH_3\ CHBr\ CH_2$ 1° Bromoalkyl free radical (less stable)

$CH_3\ CH\ CH_2\ Br$ 2° bromoalkyl free radical (more stable)

$CH_3 —CH —CH_2 —Br + HBr \to$
More stable free radical

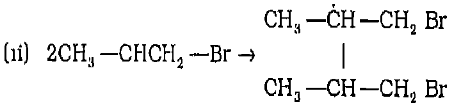
$CH_3 —CH_2 —CH_2 —Br + Br$
(Anti MK product)

Termination

After sometime the reaction comes to a standstill partly because of the consumption of the reactants and partly because of consumption of free radicals. Chain termination occurs by combination of bromine free radical with themselves or with alkyl radicals or by coupling or disproportionation of alkyl radicals giving rise to various side products.[8]

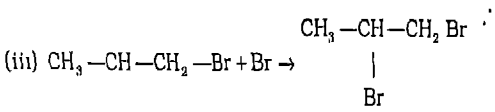
(i) $\dot{B}r + Br \to Br—Br$

(ii)



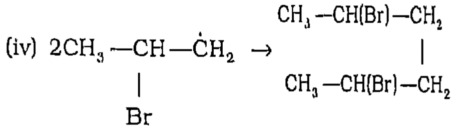
$$2CH_3—CHCH_2—Br \to \begin{array}{c} CH_3—\dot{C}H—CH_2\,Br \\ | \\ CH_3—CH—CH_2\,Br \end{array}$$

(iii)



$$CH_3—CH—CH_2—Br + Br \to \begin{array}{c} CH_3—CH—CH_2\,Br \\ | \\ Br \end{array}$$

(iv)



$$2CH_3—CH—\dot{C}H_2 \to \begin{array}{c} CH_3—CH(Br)—CH_2 \\ | \\ CH_3—CH(Br)—CH_2 \end{array}$$
$$|$$
$$Br$$

Thermodynamic Considerations

It is only the addition reactions of H-Br and not H-Cl or H-I which shows the peroxide effect. The reason being that their relative bond strengths are in the order of HCl > HBr > HI.HCl bond is too strong to break into free radicals while HI bond breaks easily into free radicals. The iodine free radicals are not reactive enough to add on a double bond but coupled together to form iodine molecule and thus breaks the chain reaction continuity. The above fact can also be explained on the basis of the energy associated with each chain propagating step as given below:

Step I

$X + CH_3 — CH = CH_2 \to$
$CH_3—\dot{C}H—CH_2X$

X	ΔH
Cl	-ve
Br	-ve
I	+ve

Step II

$CH_3—CH—CH_2X + HX \to$
$CH_3CH_2CH_2—X + X$

X	ΔH
Cl	+ve
Br	-ve
I	-ve

For addition of H-Br, both the steps are exothermic, thus accounting for easy addition reactions. In case of HCl, the first step is exothermic and hence the addition of chlorine radical yields chloroalkane free radicals readily but since the second step is endothermic, the initially formed radical is unable to decompose HCl further and hence polymerisation begins to compete with simple addition and that is why the polymer like $Cl—CH_2—(CH_2)_{n+1}—CH_3$ have been reported in literature[8]. For addition of HI the first step of the chain propagation is endothermic and thus HI does not add to the olefins by a free radical mechanism at all.

Conclusion

Classical definition of MK rule, no doubt helps generally in deciding formation of the major product but it does not give answers of questions like why and how? Besides getting answers of these questions, electronic factors come to the rescue of the learners in deciding nature of the product formed in new situations where rearrangement of carbocation takes place and where both inductive and hyperconjugative effects are the competitive factors. It is hoped that the electronic interpretations given in the paper will help in developing a new insight amongst the readers based upon reasoning to predict formation of the major product during studies of electrophilic addition reactions of unsymmetrical alkenes and alkynes with various addenda. Efforts of authors will be fructified if students get discouraged for rote memory in writing the addition products in such cases, start arguing, give reasons and predict formation of the major product based upon the role of different electronic factors. After going through the paper, the readers may try their hands and brains on the problems given in the exercise.

Exercise:

1. Compound 'A' on reacting with dry HCl gas forms compound 'B' but on passing through red hot iron tube at 873° K 'A' forms compound 'C'. Compound 'A' is used for welding purposes and for ripening of fruits. Compound 'B' on reacting with compound 'C' in the presence of only $AlCl_3$ forms compound 'D'. Compound 'D' is used for manufacture of 'use and throw crockery' but compound 'D' on treatment with HBr produces optically inactive compound E. What are compounds A, B, C, D and E?
2. Compound 'A' is an unsaturated compound but takes up two moles of Br_2 and decolorises it On treatment with ammoniacal $AgNO_3$ it forms a white ppt and forms monosodio derivative with sodamine Compound 'A' on ozonolysis forms compound 'B' but on treatment with HOCl forms compound 'C' of molecular formula C_4H_7OCl. What are compound A,B and C? Also write the reaction sequences.
3. Compound 'A' on treatment with 42% H_2SO_4 and 1% $HgSO_4$ forms compound 'B' which condenses in the presence of dilute NaOH to form compound 'C'. Compound 'C' on heating with $KHSO_4$ forms compound D of molecular formula C_4H_6O. Write structures and names of compounds A, B, C and D alongwith sequence of reactions
4. Compound 'A' is obtained by dehydrohalogenation of 1,2-dichloropropane on treatment with alcoholic KOH. Compound 'A' on acidic hydration forms compound 'B' which on distillation with conc. H_2SO_4 produces compound 'C'. Compound 'A' on treatment with acetic acid forms compound 'D'. Write structures of compounds A, B, C and D alongwith sequence of reactions.

5. Predict the predominant product obtained by addition of H-X to each of the following alkenes.
   - (i) $CH_2 = CCl_2$
   - (ii) $(CH_3)_2{-}C = CCl_2$
   - (iii) $CF_3 - CH = CH{-}Cl$
   - (iv) $CH_3OCH = CH_2$

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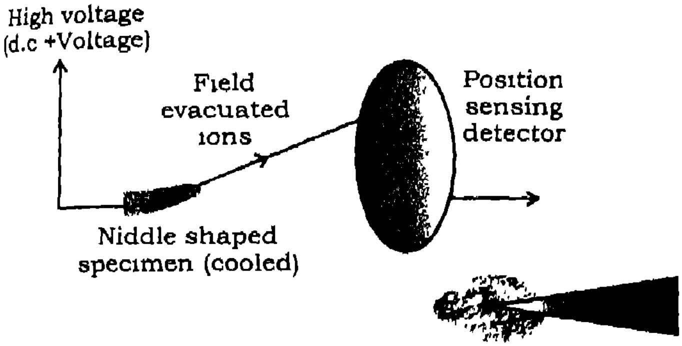
Clear View of Single Atoms

Slanniforth Webb, LPS Special Correspondent

- Single atoms removed from specimen and identified by time -of-flight mass spectrometry
- Position - sensing yields original surface position of atoms with sub-nanometre spatial resolution



When an ion strikes this position detector it causes a cloud of electrons to be given off from the other side of it and which is pulled towards another positively charged detector.

3-dimensional atom probe

Seeing is believing: the 3DAP is really a miniature particle accelerator in which the accelerated particles are used not to smash atoms but to reveal the structure of the material they come from. Illustration: Professor George Smith.

THE ability to see single atoms may soon become an everyday occurrence, thanks to the development of advanced three-dimensional atom probes (3DAPs) by scientists at Oxford University in the United Kingdom.

3DAPs now in use — and developed by Professor George Smith, Head of the Department of Materials Science at Oxford with Dr Alfred Cerezo and other colleagues, through a high-tech spin-off company Kindbrisk — are thought to be the world's most advanced. They are able to image and resolve all the isotopes (different forms of atoms) of every element in the periodic table of the elements.

The 3DAP is really a miniature particle accelerator in which the accelerated particles are used not to smash atoms but to reveal the structure of the material from where they come.

A fine needle made from a sample of such material, with an ultra-sharp tip, is electrically positively charged with a very brief, high voltage pulse of electricity. This has the effect of ionising—positively charging—some of the atoms on the tip of the needle, converting them into positive ions.

These positive ions repel and are repelled by similar positive charges on the needle of which they form part. The violent repulsive force is enough to drive some of the surface ions away from the surface and towards a detector which records their time of flight and the direction from where they came.

In the more advanced instrument developed by Smith and Cerezo in 1986—the first working 3DAP in the world—the ions strike a detector that records their time of flight, giving the depth of the layer of atoms from which they came in the sample

When an ion strikes this position detector, it causes a cloud of electrons to be given off from the other side of it and this cloud of electrons is pulled towards another, positively charged detector

This instrument plots the position of each cloud of electrons as it arrives, with a precision from which the original positions of the corresponding positive ions and the atoms which gave rise to them on the surface of the sample can be calculated by computer.

In this way, a complete three-dimensional reconstruction of the internal structure of a sample can be obtained, with the position of every single one of the many thousands of atoms in several hundred layers, each one atom thick, precisely known.

Professor Smith points out that this has allowed scientists for the first time to relate the properties of any material to their precise atomic structure, so long as the materials conduct electricity Now, it will be increasingly possible to design materials with properties precisely predicted from their structures.

3DAPs have already proved invaluable in investigating the properties of superalloys, the nickel-based alloys used in turbines in power stations and jet engines.

Aero-engine maker Rolls-Royce has asked the Oxford team to look at such alloys to discover the precise positions of individual atoms of different elements in the structure of the alloy and to deduce from them the effects of the atoms on the properties of those structures.

Another project for the Oxford group is an investigation of the aluminium alloys used in some car bodies. Alcan, a supplier of aluminium alloy, is sponsoring Oxford research into what happens to such alloys after car bodies have been shaped and painted and when they are baked to harden the paint. The structure of the alloy also changes during the baking.

"The problem is that the alloy begins to harden too much before it gets to the car makers," said Dr Cerezo. The alloy is treated to prevent this but Alcan needs to know more about precisely how such treatments work at the atomic level.

There are plenty of other challenges for the group. Professor Smith is particularly enthusiastic about catalysis and the prospects for following the events that take place during catalysis on the atomic scale.

Especially commercially exciting is

the hope that the new instrument now being commissioned by Professor Smith and his colleagues will make it possible to use 3DAP routinely for computer hard disc quality control.

When that happens, seeing single atoms will indeed, astonishingly, will become routine

(*Source*: Reproduced from **Spectrum** online)

Teaching Trigonometric Ratios : Teachers' Perception and Students' Learning

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Regional Institute of Education,
Ajmer

It is a common observation that teachers' presentation has influence on the pupils' learning The learners usually acquire the knowledge through the practices followed by teachers in their classroom instructions.

Again, the classroom instructions followed by the teachers are based on the beliefs of the teachers. Modern researches have established this. Herrington and Cockcraft (1992) have supported this through data showing relationship between classroom teachers' beliefs about mathematics, the way teachers teach mathematics and teachers' general classroom practices. Ford (1994) in the study of elementary school teachers' beliefs about problem-solving in mathematics concluded that there existed a relationship between mathematics teachers' beliefs and classroom practices.

Through these classroom practices, the students acquire the knowledge and develop the conceptual understanding in a desired way or otherwise. This otherwise may create deficiency among the students and if a teacher is not very active and vigilant, the deficiency continues with the students about which the teachers remain ignorant.

In Mathematics, blackboard work is an essential component of instructional strategies particularly with reference to presentation of various stages of the solution of a problem or diagrammatic representations of various figures or situations. The diagrams drawn on the blackboard often create a set situation for the learners who sometimes cannot visualise the same beyond whatever was presented before them. This creates problem for the learners in using the concepts in alternative situations. The teacher through his strong beliefs, does not provide alternative situations in the classroom practice and the student goes on with the deficiencies.

Trigonometry which is introduced at secondary level and provides a very useful tool for solving problems in other branches of mathematics. The trigonometrical ratios are based on the properties of a right—angled triangle and relate the angles of the triangle with its sides. For example, while calculating the cosine of an angle, it is essential to correctly identify the base and the hypotenuse. It is not difficult for a student to correctly identify the hypotenuse but at times it is found that the corresponding base is not correctly identified. This creates problem in calculating correct values and using them subsequently in different situations.

In this context, the present study was undertaken to find out the extent to which a student who understands the concepts of trigonometrical ratios and is able to solve them in a routine situation, can apply the same in a changed situation. The study was conducted on 20 Class XI students of the Demonstration Multi-purpose Higher Secondary School, Ajmer. The study was undertaken as a part of practicum prescribed for B Ed. (2 Yr. course) started at the Regional Institute of Education, Ajmer.

Problem

The purpose of this study was to find answers to the following questions:

(i) How far are the students able to identify base, perpendicular and hypotenuse when a right-angled triangle is rotated?

(ii) Whether the students are able to calculate the trigonometrical ratios when sides are given as irrational numbers?

A test containing six questions, each having two parts, was administered to the sample. The responses of these twenty students have been recorded in the following table (see appendix 1 for test paper).

Analysis

Question No. 1 part (a) is the case which is normally shown by the teachers on the blackboard and thus correctly solved by 95 per cent students. In part (b) of the same figure, the correct responses have dropped to 65 per cent i.e., a fall of 30 per cent.

Thus, there is a steady fall in the percentage of correct responses to Q. Nos. 1 to 4 and the lowest percentage of correct answers is in Qs 3 and 4. It is evident that the situations in these questions are usually not presented by the teachers on the blackboard.

It is also evident as per the responses of Q.5 and Q.6 that the sides represented by irrational numbers do not pose any problem to the students.

Question No.	*Part*	*Correct*	*Incorrect*	*Not attempted*
1	a	19	1	0
	b	13	7	0
2	a	13	3	4
	b	14	2	4
3	a	7	8	5
	b	8	7	5
4	a	8	7	5
	b	6	9	5
5	a	18	2	0
	b	17	3	0
6	a	14	5	1
	b	14	5	1

On interviewing, the students told that the figures drawn on the blackboard always show base as a horizontal line and perpendicular as a vertical line. Due to this, they are not in a position to properly identify base and perpendicular in figures which are represented otherwise by way of rotating the triangle

The regular teachers were then asked to draw right-angled triangles on paper while introducing trigonometrical ratios It is interesting to note that every teacher drew the triangle with base horizontal and perpendicular as vertical line. They were then asked whether they would like to draw right Angled triangles in some alternative way. The reply given by most of them was that they can draw the triangle in some other way but normally they draw the triangles in the same manner as drawn earlier.

Suggestions

It is therefore, suggested that the teachers while introducing these ratios should draw figures in different ways. The teacher may initially draw the triangle with base horizontal. A number of different right-angled triangles may then be drawn on the blackboard. The students may be asked to identify the hypotenuse as it is very easy task The base may then be identified as the side of the triangle which makes the given angle with the hypotenuse. The perpendicular may then be identified as the third side. The teachers may use the models of right-angled triangles which can be placed in any position and shown to the students

This approach, when used in the classrooms gave excellent results and more than 90 percent of the students could correctly find out the trigonometrical ratios for the right-angled triangles presented in any position.

This task was undertaken as a part of pre-service Teacher Education programme to make the prospective teacher aware about the practice followed by teachers and its implication in developing proper understanding among students. The teachers should keep in mind that pupils' understanding of basic ideas develop slowly. Teaching needs to be planned so as to offer repeated opportunities to meet the same basic ideas, variety being provided through differences of contexts.

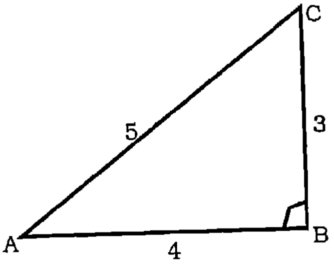
All this should form the part of pre-service training programme as rightly mentioned by herrington and Cockcraft (1992).

The beliefs that teachers hold about mathematics and how it is learnt, is certainly influenced by the approaches taken in the mathematics education course. The teacher education programme in mathematics should, therefore, include all such activities which help a prospective teacher to correctly assess the learning needs of the students, find out the shortcoming of the teaching practices and modify the practices for developing a better learning environment.

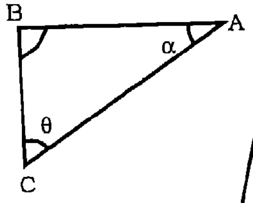
APPENDIX 1

TEST PAPER

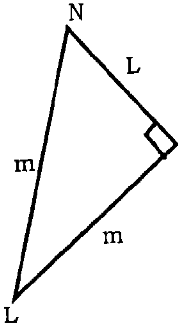
1. In the given figure, find the values of
   (a) Sin A (b) Cos C



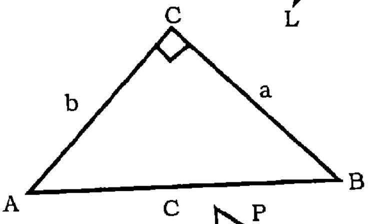
2. In the given figure, find the values of
   (a) Sin θ (b) Sin α



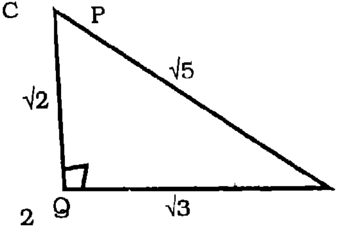
3 In the given figure, find the values of
   (a) Cosec L (b) Sin N



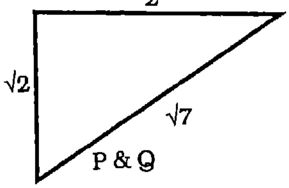
4. In the given figure, find the values of
   (a) Sec A (b) Cosec B



5. In the given figure find
   (a) Sec R (b) Cosec P



6 In the given figure, find
   (a) Cot Q (b) Cot P



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Activity Based Learning—*Should We Use Pesticides to Produce Food?*

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In view of the great strides that Science and Education has made in recent years, it has become necessary to expose the students to the modern ideas and trends in Science through education at school level so that they keep pace with the modern developments. To make the study of the subject interesting and intelligible, a new approach has been attempted in which the pupils are made to learn through activities instead of the traditional way of teaching which leads to memorization of facts. This approach is believed to promote a sense of experimentation, and inquiry in the young minds for better understanding and to appreciate learning. This paper discusses activity based learning on few topics covered in Class X Science text-book

Purpose

This activity focuses on the use of pesticides in food production. During this activity students should research how and why pesticides are used in agriculture, what legislature is in place to protect the environment, and discuss why these chemicals are potentially harmful to consumers. The following information can be used to start the class discussion. It provides a background into the different points of view (the farmer, the critic, the scientist, and the government) This topic would be an excellent debate. The activity could be extended to allow the students to research the differing points of views before discussing the ideas in class.

Background

Sustainable agriculture is described as "systems that are economically viable and meet society's needs for safe and nutritious foods, while conserving or enhancing India's natural resources and the quality of the environment for future generations". It is estimated that food production must increase by at least 1 percent per year in order to meet the demands of a growing world population. Three ways in which this increase can be achieved are by —

1. Decreasing food demands by reducing the rate of population growth and food wastage.
2. Increase the amount of land available for agriculture.
3. Increasing the efficiency of agricultural techniques and farming methods.

In the past most farms consisted of small-scale farms. These farms were self-sufficient and could produce enough food to support small local populations. However, as people emigrate to larger urban centres the need for food increases while the amount of land and the number of farms decrease. This forces the farms to develop more efficient ways to produce food. Several strategies have been implemented to meet the increased demand. These include: improved equipment and training, specialization, increased size of farms, and the use of pesticides. These changes have not arisen without costs. The increased farm size could lead to soil erosion and the pesticides have the potential to pollute groundwater and local aquatic habitat.

Activity

Divide the class into four groups. One group will represent the farmers, another group the critics, third group the scientists, and the last group will represent the government. The views of each of the groups are outlined below.

Farmers- Believe that the benefits of responsible use of pesticides outweigh the risks. Training is available to teach the farmers how to use the chemicals responsibly and then try to keep pesticide use to a minimum.

Critics- Believe that the environmental risks outweigh the benefits. They say that the farmers are damaging the land and endangering the environment. Would like to see less invasive farming methods used (e.g. organic farming).

Scientists- All human activities have an impact on the environment and this includes agriculture. Scientists believe that research is key to maximize the benefits while reducing the risk to the environment Research to produce healthier plants which require less pesticides, and alternative methods of disease and pest control is under way.

Government- is responsible for establishing laws that will protect the environment and they ensure that polluters are caught. However, the government must ensure that sustainable agriculture is maintained. Therefore, it sponsors research to enhance agricultural practices and establishes programs to educate farmers on soil conservation, pesticide use, and preservation of the environment

Questions for discussion

1. What are the benefits of using pesticides in agriculture?
2. What are the risks associated with pesticide use?
3. Should farmers be allowed to use pesticides?
4. What are some alternative methods of pest control?

Alternative Activities

1. You may also consider asking experts (farmers, chemical companies, scientists) to come to the school and address these issues.
2. Have the students interview an expert in the use of pesticides and present their findings to the class.

ACTIVITY BASED LEARNING: TOXICITY

Activity focus

Students will examine the toxicity of common pesticides and then examine some pest control alternatives in terms of Integrated Pest management (IPM).

Background

Most common pesticides used for home, garden and recreational uses belong to chemical families that are less toxic to humans or animals; they do not pose a cancer risk to humans and do not accumulate in the environment when applied and used properly. Every pesticide imported into, sold or used in India must first go through a registration process

All pesticides must be registered under the Government Act to ensure that our health and environment remain safe when pesticides are used. To receive registration, the manufacturer must follow the registration process administered by the Government of India. A scientific evaluation of the product is performed by Government body. This takes years, as the study includes long and short term health effects of the user, exposure to bystanders, residues in food, ground water contamination, effects on wildlife and environment. Registration will be granted only if the pesticide's safety, merit and value for the proposed use are found to be acceptable. For general information about pesticide testing and regulation, look at the Pest Management Regulatory Agency website http://www.hc-sc.gc.ca/pmra-arla/

Each State has legislation dealing specifically with pesticide use. Specifically, they deal with the training and licensing/certification of applicators, spill response, monitoring, compliance, enforcement, research and education, related to pesticide use.

The effect of pesticides on human health is a current controversy. While many studies can prove no link between pesticide exposure and such health concerns as Alzheimer's, Parkinson's, Breast Cancer, Prostate Cancer and decreased male sperm counts, other studies do claim a correlation. Pesticides should be handled carefully and, if improperly used, can enter the human body through three main routes: oral (by swallowing), dermal (skin contact) and inhalation.

Acute toxicity is a measure of how toxic a pesticide is after a single exposure LD50's (LD50 = milligrams pesticide/kg body weight) are determined this way and pesticides are generally rated this way. Chronic toxicity is a measure of how toxic a pesticide is over a period of time and after repeated exposure and represents the dangers associated with chemical accumulation in the body (e.g. chlorinated hydrocarbons). Oral and dermal acute toxicities are measured by LD50 which stands for 'lethal dose' where 50% of test animals are killed by this dose. The lower the LD 50 number of a pesticide, the more toxic it is. Inhalation toxicity is measured by LC50 which stands for 'lethal concentration'.

(LC50 = ppm pesticide vapour in air or ppm pesticide [mg/L] in water.) The hazard of any product is dependent on both the toxicity and the level of exposure or dose.

RISK = TOXICITY × EXPOSURE

Almost any substance, like table salt and vitamins, is toxic if we consume too much of it. No matter how toxic a substance may be, if the degree of exposure is kept low enough, risk can be kept at an acceptable level and can be managed.

Other problems may be associated with pesticide use such as pesticide resistance, minor pest resurgence and the emergence of new pest species. These problems have caused scientists to search for alternate or complimentary pest control approaches Integrated Pest management (IPM) is a system of managing pest problems that looks at more than one control method. These control methods include:

cultural —resistant varieties
physical — barriers set up to control pests
biological — viral or bacterial pest diseases
genetic – genetically modified organisms
chemical — control

Teaching/Learning strategies

- Review the terms toxic, acute toxicity and chronic toxicity. Discuss the three main routes that toxins can enter the body, i.e , oral, dermal and inhalation and how these toxic levels can be measured (LD50/LC50).
- Distribute resource sheet "Acute Toxicity ' Levels of Common Pesticides". Have students look through the list and write down chemical names that they recognize. Bring special attention to familiar items such as nicotine, caffeine, aspirin, and table salt.
- Discuss how everyday chemicals as seemingly harmless as table salt can be considered toxic to some degree depending on the dose (e.g. the salt in a salt cellar could kill a baby!) and that many pesticides are considerably less toxic. Notice that insecticides are relatively more toxic than fungicides and herbicides. Comment on the reliability and significance of this information.
- Brainstorm some alternatives or complimentary practices to chemical pesticides.
- Define the term "Integrated Pest Management" or IPM Give students resource sheet on IPM.
- Create a chart outlining the advantages and disadvantages of IPM.
- Students will complete the assignment on the IPM resource sheet. Students will need to research the identification and monitoring techniques, action threshold, and action for their specific study pest. You may wish to have students actually perform the identification and monitoring techniques they include in their research.

Assessment

Assess students' achievement of the following elements of their IPM strategy report. It is suggested that these elements be given to students before the assignment.

research — accurate, well-referenced
strategy — includes the three steps
presentation—formation, organization, neatness.

ACTIVITY—THE FOOD CHAIN GAME

Background information

The Past

In the 1930's, Paul Muller, a Swiss chemist, discovered a chlorinated hydrocarbon—DDT This inexpensive, broad-spectrum, persistent chemical that was extremely toxic to insects and yet was not toxic to humans and other mammals appeared to be the answer to many pest problems It quickly became useful to control lice in World War II resulting in less typhus fever. It was used to control mosquitoes to reduce malaria, to control spruce budworm and beetles spreading Dutch elm disease in forests and of course it was used to help grow more economically productive crops. However, in the 1950's Rachel Carson started to look into the effects of DDT on wildlife Fish-eating birds, robins and other insect-eating beings were dying from eating prey laden with DDT. Carson's book, *Silent Spring*, chronicles a message that insecticides can have dangerous environmental effects. She is credited with the creation of the Environmental Protection Agency (EPA) The EPA worked to ban the use of DDT in the early 1970's in the United States though it is still believed to be entering the Great Lakes ecosystem through rainfall and dust sources halfway around the world to this day.

The study of DDT provides a good example of bioaccumulation and biomagnification of the chemicals in the ecosystem. Bioaccumulation is the accumulation of higher and higher concentrations of potentially toxic chemicals in individual organisms. It occurs in the case of chemicals that are ingested but cannot be broken down or excreted. Biomagnification is the bioaccumulation occurring through several levels of a food chain.

The Present

Pesticide product technology has changed Many new pesticides are biologically based and breakdown readily upon contact with the soil or in reaction to sunlight. They are much more target-specific and are less likely to damage non-target organisms The persistence of the chemical is rigorously tested during the pesticide registration process by the Pest management Regulatory Agency. It is possible that the long-term effects and overall impacts of new and existing chemicals on ecosystems can only be partially evaluated by current laboratory testing procedures.

This activity outlines a popular simulation game illustrating bioaccumulation and biomagnification related to a specific learning expectation in the new curriculum Teachers should convey to their students that bioaccumulation of DDT happened with the old product technology and that New technology prevents this from happening again. To illustrate this to students, the game should be played first in the past, as the "worst case scenario" Then it should be repeated using a more contemporary "best case scenario", followed by a discussion of the two scenarios.

In many ways the scenario can be compared with the changing technology in the automobile industry Twenty years ago, emission standards on vehicles were not regulated or a cause for concern. Damage was caused (and, to some extent, continues to be caused) by old auto technologies. New vehicles now have a more rigid emission standard which is regulated and many areas of the country require that older vehicles now are tested and repaired to decrease pollution.

Materials needed

- White construction paper squares (two-thirds of total)
- Coloured construction paper squares (one-third of total)

  (30 paper squares per student is recommended)
- One paper bag per person in the role as a 'grasshopper'

Teaching/Learning Strategies

- Ask students to identify what they perceive to be the risk associated with pesticide use.
- Define the terms food chain, ecosystem, bioaccumulation and biomagnification and use DDT as a case study example.
- Take students outside, to a gymnasium or large open space and play the pesticide food chain game as outlined below.

The Game

Worst Case Scenario

Divide the class into 3 groups: grasshoppers, shrews and hawks—with approximately 3 times as many shrews as hawks and grasshoppers as 3 times as many as shrews.-(example: in a class of 26 students, there would be 2 hawks, 6 shrews and 18 grasshoppers). You may wish to mark them for easy identification using arm ties or bandanas Give each grasshopper a bag 'stomach' and then without the students looking, spread the paper squares of 'food' all over the playing areas.

Instruct the grasshoppers to enter the playing area and to quickly gather as much food as they can in 30 seconds while the hawks and shrews sit on the sidelines and watch.

(*Best Case:* Grasshoppers are the target organism so they should hold on to all their food.)

Allow the shrews to enter the playing area to catch the grasshoppers (while they are still looking for food) for a short amount of time depending on the size of the playing field. When a grasshopper is tagged by a shrew, he/she must give the bag of food to the shrew and then sit on the sidelines.

(*Best Case:* Have the shrews remove most of their red coloured paper squares and put them back on the ground—since they are not the target organism, the red squares should not adversely affect them)

Allow the hawks to enter the playing area to catch the shrews while they are still hunting for grasshoppers for a set period of time. Same rules apply—when a shrew is caught it must give the bag of food to the hawk and sit down.

At the end of the allotted time, ask students to circle together and look at the food bags they have, or report if they were eaten. Count the number of grasshoppers and shrews left and the food squares (white and coloured) in their stomachs. Ask the hawks to empty out their bags and count the number of white and coloured squares.

Inform the students that the coloured squares represent a pesticide. If the live grasshoppers have a coloured square in their stomach, they are dead. If the remaining shrews have half or more of their squares as coloured, they would be considered dead.

(*Best Case:* Shrews would not die as they would have very little, if any, red squares in their stomach; as well, it is possible that the pesticide has broken down already in the environment.)

The hawk with the highest number of coloured squares will not die at this time, but will not be able to reproduce and the remaining hawks are not visibly affected at this time.

(*Best Case.* The hawks will not be affected by so little, if any red squares.)

Debrief about what has occurred using the new technology and how this affects people.

Case Study (from Project Wild)

An ecologist studied the presence of a toxic chemical in a lake. He found the water had one molecule of the chemical for every billion molecules of water (1 ppb). The algae had one part per million (1 ppm) of the toxic chemical. Small animals, zooplankton, had 10 ppm. Small fish had 100 ppm. Large fish had 1000 ppm. How do you explain the increase in this toxic chemical to 1000 ppm for the large fish? Use a drawing to help support your answer. The ecologist found the chemical was a pesticide which has been sprayed on cropland 160 kilometres away from the lake. How did so much of it get into the lake?

Assessment

Give 3 example of other food chains involving humans in which pesticides may enter. Discuss the consequences of these pesticides entering these food chains.

Determination of Anti-Nutritional Amines in Non-Alcoholic Wines Using High Performance Liquid Chromatography

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NON-ALCOHOLIC fruit wine is consumed in considerable quantities in Nigeria Medium levels of anti-nutritional amines are usually observed in fermented products such as wine [1]. The occurrence and formation of anti-nutritional amines, including spermidine and spermine formed from putrescine have been studied in beers produced in Italy [2]; Spain [3] and Germany [4].

Naturally occurring anti-nutritional amines are toxic compounds, which are widespread in foods [1]. They arise mainly from microbial decarboxylation of the corresponding amino acids or by transamination of aldehydes by amino acid transaminases. The most common monoamines—histamine, tyramine and tryptamine are derived from histidine, tyrosine and tryptophan respectively, while the diamines—putrescine and cadaverine are formed by microbial decarboxylation of lysine and ornithine respectively.

Wines have a low dry matter content and a chemical composition suitable for undesirable changes by microbial enzymes [5] Yen [6] also reported that the formation of natural anti-nutritional amines in food could be a process that participated in the undesirable changes especially during storage.

At low concentrations, natural anti-nutritional amines are essential for many physiological functions, while high concentrations may cause some deleterious effects. They function as psychoactive and/or vasoactive agents, Psychoactive amines affect the neurotransmitters in the central nervous system while vasoactive amines act either directly or indirectly on the vascular system as vasoconstrictors (e.g. tyramine) or vasodilators (e.g histamine) [1]. A number of symptoms occur following excessive oral intake of anti-nutritional amines. Toxicity strongly depends on the efficiency of detoxification, which may vary considerably between individuals and is affected by several factors. Normal intake of these amines is metabolised in the intestinal tract by a fairly efficient detoxification system based on the activities of monoamine oxidase (EC 1.4.3 4) and diamine oxidase (EC 1.4.3.6) [7]

In non-fermented foods, the anti-nutritional amines appear as a result of undesirable microbial activity Very high levels of histamine are found in spoiled fish. A number of anti-nutritional amines occur in some well-matured cheese, fish and meat products, as well as in some fruits and vegetables such as spinach and tomato.

The interest on non-alcoholic wine was predicated on the report [5] that alcohol inhibits the activity of both monoamine oxidase and diamine oxidase Again, non-alcoholic wines are becoming important and favoured drinks in most Nigerian homes, hotels, and during ceremonies. Thus, non-alcoholic wine could represent an important source of intake of anti-nutritional amines. Thirdly, statistical consumption *per capita* was unavailable at the Federal Ministry of Trade and Industry.

Also, data on levels of anti-nutritional amines in Nigerian wines were unavailable. The aim of this research was to evaluate the concentration of some anti-nutritional amines in Nigerian non-alcoholic wines and the effect of storage conditions on their formation after opening.

Materials and Methods

Sample Collection: Six brands of highly consumed non-alcoholic fruit wines were purchased from supermarkets in Port Harcourt – a major industrial city in Southern Nigeria.

Storage Conditions: Test wine samples were opened and analyzed for the four anti-nutritional amines as described below, and then stored at two conditions. The first condition was storage in the dark. Both dark brown and clear glass bottles of wine were wrapped with black cellophane wrappers and kept in a cupboard in the laboratory, while the second condition was by placing the wines on the shelf. The two conditions enable us to study the exclusion of light during storage.

Determination of Anti-nutritional Amines: Determination of amines in the samples was carried out after forming their N-Benzamide derivative with benzoyl chloride using a high-pressure liquid chromatographic (HPLC) technique with isocratic elution [8]. Histamine was determined in 35 cm^3 of wine degassed under vacuum, to which 0.5 cm^3 of 1.0M 1,7 - diaminoheptane was added as an internal standard. The mixture was made alkaline with 2.15M sodium hydroxide solution followed by the addition of 1.0 cm^3 of 0.078M benzoyl chloride. The procedure continued with acidification to pH 6.0 with 60% perchloric acid, addition of a 2.0 cm^3 of 1.55 mM sodium diphosphate buffer and 0.15g sodium chloride and mixed. The N-benzamides formed were extracted into 10 cm^3 of diethyl ether. A 5.0 cm^3 of the extract were evaporated with warm air stream and the residue was dissolved in 0.4 cm^3 of mobile phase (71% v/v) methanol in water. A 10 µL aliquot of the extract was then injected for HPLC analysis.

Tryptamine, putrescine and cadaverine were determined in 40 cm^3 of degassed wine. A 0.5 cm^3 solution of 1 0M 1,6 - diaminohexane was added as an internal standard. The following procedure was the same as described above, but only 1.0 cm^3 diethyl ether was evaporated and dissolved in 0.3 cm^3 of 63.5% (v/v) methanol in water. The injected volume was again 10 µL.

Separation of N-benzamides was carried out using a high performance liquid chromatography HPP 4001 on an HPLC Column SGX-C$_{18}$ 3mm × 150 MPa with a flow rate of 0.5 Cm^3 $_{min}$$^{-1}$ at 254 nm. The peak areas were integrated by using an Apex integrator. The retention times were 10.1, 8.4, 6.5 and 7.4 min for histamine, tryptamine, putrescines and cadaverine respectively.

Statistical Data Analysis: The analytical data were calculated from the calibration values for the individual amines designed for concentration ranges of 5-30 mg/L. The correlation coefficients for the amine calibration curves ranged between 0.997 and 0.999. The detection limits were very similar for all the amines, with values of about 0.3 mg/L. Reproducibility of the analytical procedure was tested by parallel analyses of seven samples from one bottle of wine. Relative standard deviations were 8 5%, 11.4%, 7.6% and 2.7% at mean concentrations of 0 4, 1.5, 5.9 and 10.5mg/L for histamine, tryptamine, putrescine and cadaverine respectively for dark glass bottles and a standard deviation of 10.7%, 15.5%, 6.4% and 3 2% at mean concentration of 0.6, 1.01, 8.6 and 15 7 mg/L for histamine, tryptamine, putrescine and cadaverine respectively for clear glass bottles.

To assess the relationships between the brand of wines, the storage conditions and the concentration of anti-nutritional amines during the monitoring periods, the analysis of covariance (**ANACOVA**) at $\alpha = 0.05$ was applied. The homogeneity of the **ANACOVA** was tested by the F_{max} test [9]. Consequently, parametric single factor **ANACOVA** was performed using the combined linear regression model-analysis of variance procedure [10] for variables that cannot be held fixed but can be measured A null hypothesis and its alternative were tested:

TABLE 1

The concentration (mg/L) of anti-nutritional amines in the different brand of wines in dark bottles*

	Anti-nutritional amines			
Wine Brand	*His*	*Try*	*Put*	*Cad*
A	0.6 ± 1.7	0.9 ± 1.5	8.5 ± 9.9	13.3 ± 19.3
B	0.6 ± 1 3	1.0 ± 1.9	7.2 ± 9 5	12.8 ± 16.9
C	0.4 ± 0.7	1.7 ± 3.5	9.1 ± 12.3	13.5 ± 18 5
D	0 52 ± 1.0	1.7 ± 3.5	11 0 ± 14 6	14.11 ± 19.8
E	1.0 ± 2.1	1 5 ± 2.8	8.6 ± 9.6	13.95 ± 17 6
F	0 4 ± 0.7	0.9 ± 1.6	8.1 ± 7.0	12.4 ± 17.9

**Results are based on zero week measurement, which represents the time of opening the wine bottle. His = histamine, Try = tryptamine, Put = putrescine, Cad = Cadaverine*

TABLE 2

The concentration (mg/l) of anti-nutritional amines in the different brands of wines in clear bottles.

	Anti-nutritional amines			
Wine Brand	*His*	*Try*	*Put*	*Cad*
A	0 15 ± 1.3	1.1 ± 1.9	8 61 ± 8.4	12.3 ± 18 3
B	0.7 ± 1.7	1 2 ± 2.1	7.8 ± 10.6	12 8 ± 17.3
C	0.3 ± 0.7	2.0 ± 3 7	10.5 ± 13 4	13.2 ± 18 5
D	0.5 ± 1.5	0.8 ± 1 3	7.2 ± 8.8	12.6 ± 12.7
E	1.0 ± 2.4	1.4 ± 2.1	9.9 ± 14 6	14 3 ± 20.13
F	0.5 ± 1.3	1 9 ± 3.6	9.6 ± 13.2	13.4 ± 19.3

1. ***H_0:*** there are no differences in the average level of anti-nutritional amines formation between the two storage conditions during the six-week monitoring period among the six brands of wine. [2] There are differences in the average level of anti-nutritional amines formation in the two storage conditions among the six brands of wine. Reject the null hypothesis, if F_{cal} > 3.59

Reagents: All the chemicals used were of analytical grade. Chromatographic determination was carried out within a week after forming the derivatives. The samples for HPLC analyses were stored at - 15°C.

Results and Discussion

The concentrations of anti-nutritional amines in the six brands of non-alcoholic wines evaluated at the two different

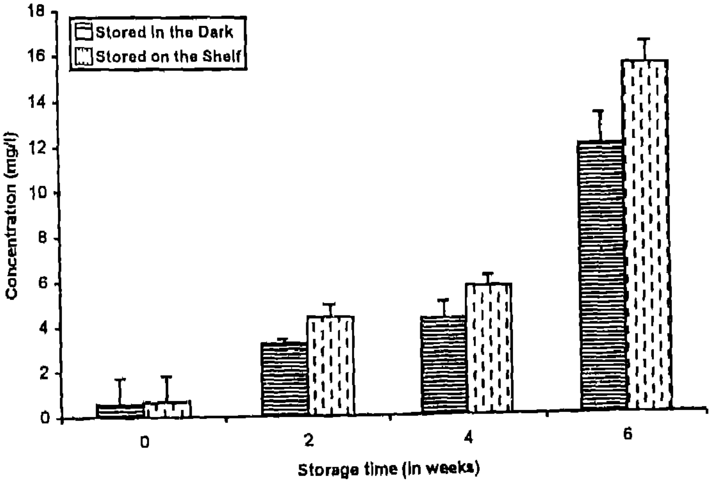

Fig. 1A: *Histidine*

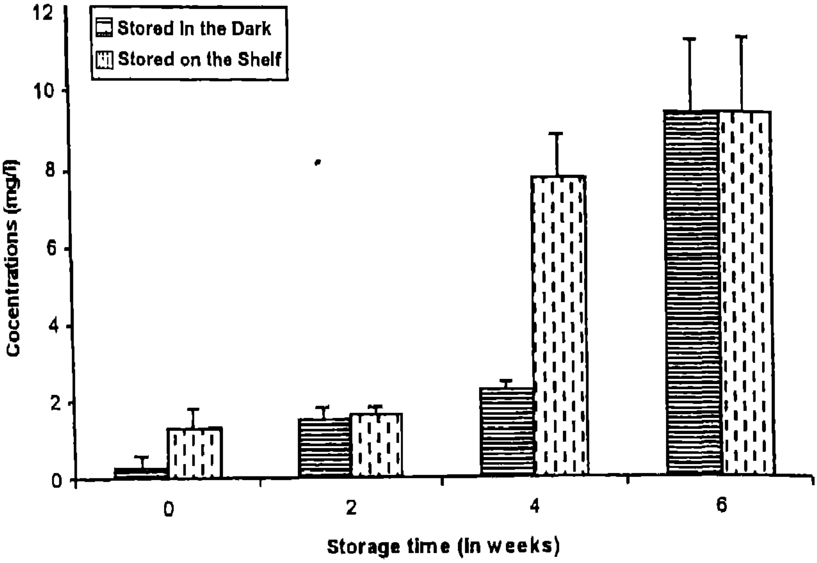

Fig. 1B: *Trypsine*

storage conditions from six Nigerian wineries are summarized in Tables 1 and 2 respectively.

Storage of wine, either table, dessert or non-alcoholic fruit wines in fridge, on wine shelf or dining table for a longer period after opening is a popular habit in Nigeria, partly because of the high cost of the commodity. The wines under investigation were stored at two conditions – representing cupboard and shelf for six weeks and tested for changes in anti-nutritional amine concentration at 2-weekly intervals.

Time-dependent amine concentration changes during storage is shown in Fig. 1A to 1D. Histidine in Fig. 1A showed that, the levels increased steadily from the time of opening until the sixth week. Wines stored on the shelf contained a higher concentration of histidine than wines stored in the dark during the monitoring period. However, there is no significant difference ($P < 0.05$) in the increase of histidine levels between the two storage conditions from week zero to the sixth week. There was no variation in trypsine (Fig. 1B) levels between the two storage conditions under investigation at weeks 2 and 6 respectively However, there was a general increase in trypsine levels from week zero to six.

Putrescine and cadaverine (Figs 1C and 1D) gave a similar pattern of change during the monitoring period. Their levels increased after opening to week two and decreased thereafter until week six. There was no significant difference ($P < 0.05$) in their levels between the two storage conditions.

These observations indicate that monoamines anti-nutritional compounds increase during storage while the diamines decrease probably due to a decomposition reaction of diamines to give monoamines over time

The uniformity of anti-nutritional amines concentrations within a brand of wine was tested by parallel analysis of seven bottles from one brand. Relative standard deviations were 9.4%, 12.5%, 6.0% and 4 4% at mean concentrations of 0.9, 1 1, 8.4 and 12 4 mg/L for histamine, tryptamine, putrescine and cadaverine respectively. The values of the deviation are comparable with those observed in testing the reproducibility of the analytical procedure. Thus, one bottle was used as a representative sample of a brand of wine

The levels of histamine in our sample ranged between 0.36-0 98 mg/L and 0 30-0 96 mg/L for wines in dark brown and clear glass bottles respectively. The percent difference in histamine concentrations among brands was between 10.56-28.74% for dark brown glass bottles and 8 98-28.74% for wines in clear glass bottles.

Tryptamine concentrations in dark brown and clear bottles among the brand of wines ranged between 0 90-1.67 mg/L and 0 78-2.00 mg/L respectively with percent distribution of 11.76-21.77% and 9.26-23-75% respectively.

Wines in dark brown glass bottles contained a purtrescine concentration of 7 21-10.95 mg/L among the different brands with a percent distribution of

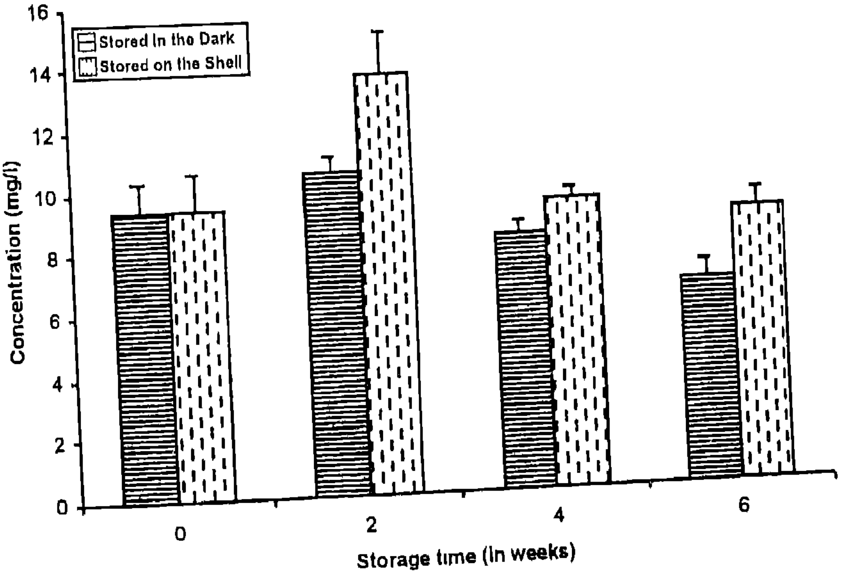

Fig. 1C: *Putriscine*

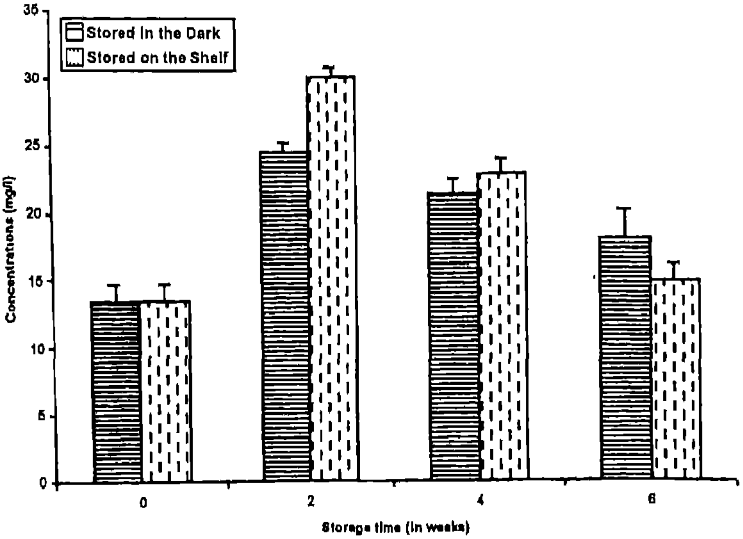

Fig. 1D: *Cadaverine*

13-74 — 20 87%, while those in clear bottles contained between 13.59 — 18 72 mg/L putrescine levels with a percentage distribution of 9.26-23 75%.

Cadaverine levels in dark brown glass bottle ranged from 12.80 — 13.85 mg/L with a percent distribution of between 15.48 – 17.67%, while levels in clear glass bottle ranged between 12.30 - 14 30 mg/L The percentage distribution of cadaverine in clear glass bottle ranged from 15.67 - 18.22%.

The percentage distribution of anti-nutritional amine concentration among the brands of wine tested in dark brown or clear bottles showed that light does not have a significant effect on the formation of the amines during storage.

Comparable results among brands were also reported elsewhere [5]. However, absolute concentration levels seem to be characteristic of a winery, and to a limited extent of the different types of wines produced within this winery. Similar conclusions were reached for *histamine* and tyramine in Spanish beers [4], and for tyramine, cadaverine and, to a limited extent, *tryptamine* in German beers [5]

The changes in the amine concentration during the monitoring period are further presented in Table 3. The data showed that the levels of the monoamines-histamine and tryptamine increase with storage while that of the diamines-putrescine and cadaverine decreases with storage.

Analysis of covariance **ANACOVA** at $\alpha = 0.05$ of the relationship between wine types, biogenic amine formation and the two storage conditions during the six-weeks monitoring period showed that Fcal (2.63) < $F_{0\,05}$ (3.59) which enables the acceptance of the null hypothesis. In other words, we can conclude, that formation of biogenic amines in wines

TABLE 3

The average concentration of anti-nutritional amines at the two storage conditions (mean ± sd in mg/L).

Anti-nutritional Amine	*Storage time* (in weeks)*	*Storage Conditions*	
		Dark	*Shelf*
His	0	0.6±1.1	0.7±1.1
	2	3.2±0.2	4 4±0.5
	4	4.3±0.7	5.7+0.5
	6	12.0±1.3	15 5±0 9
Try	0	1.6±1 8	1.6±1.8
	2	0.3±0.03	1.3±0.3
	4	1 5±0.3	1.6±0 2
	6	2 3±0.2	7 7±1.1
Put	0	9 4±8.9	9 4±8.9
	2	10.5±0.5	13 6±1 4
	4	8.3±0.4	9.4±0.0
	6	6 6±0.6	8 9±0 6
Cad	0	13.4±13 0	13 4±13.04
	2	24.3±0.8	29.9±0.7
	4	21.3±1 2	22 7±1 2
	6	17.9±2.3	14.8±1.4

*Storage time of zero indicates the time of opening the wine bottle

is dependent on the wine type, storage condition and the duration of storage.

About 99% of samples contained less than 2 mg/L of histamine and nearly 80% of samples had a tryptamine level below 3mg/L while 10mg/L for putrescine is exceeded in nearly 30% samples. The maximum levels determined in the wines tested were 1.0, 2.0, 11.0 and 14.3 mg/L for histamine, tryptamine, putrescine and cadaverine respectively.

These values compared well with data reported for numerous European and Cuban wines and beers [11]. However, increased levels of putrescine and cadaverines were observed in some Nigerian wines. The concentrations reported in European wines are within the range 0.2 - 8.0 mg/L whereas the upper values was exceeded in about one-third of our samples.

The observed amine concentrations can be considered as harmless for most wine consumers, however, anti-nutritional amine concentrations, especially the monoamines may increase significantly, during long-term storage.

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Concept Development of Volume Enclosed by Simple Surfaces and their Measurement

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If an elemental area is made to move in a direction perpendicular to its plane, it would traverse some definite volume. The magnitude of volume so traversed by the area is just the product of the magnitude of the areas and displacement caused to it. Here we may remember that

(i) the area is a vector quantity and may be represented by an outward drawn normal on it whose length is equal to that of the magnitude of the area It is advantageous to represent the normal at the point that corresponds to the centre of the gravity of the given area. For the sake of convenience (to avoid triviality), we will take the centre of gravity of area as its representative point[1].

(ii) Area vector $\vec{A}$, when displaced through a vector length $\vec{d}$ will scan a volume $\vec{A}.\vec{d}$.

Let us examine a few cases for finding volume on the above concepts.

Case 1: When a Plane of area $\vec{A}$ moves

Consider a plane figure bound by ABCD as boundary. Essentially it can move in two directions· (i) direction which coincides with the plane and (ii) direction along the direction of area i.e., perpendicular to its surface. (Other directions are just different linear combinations of vectors along these two directions).

When the plane figure moves in the direction of its plane, it scans just additional area

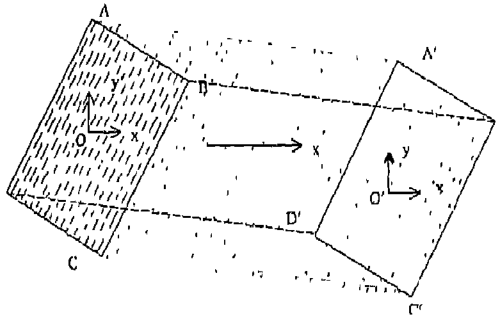

Fig. 1

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[1] Representative point or centre of gravity of area is that imaginary point in the area at which whole area may be assumed to be concentrated. In other words, it gives same result for a physical process as that due to real distribution of area.

Fig.1 shows the plane contained in X-Y direction As this plane moves along X direction, it scans the additional area AA'B'C'CBA. So the total area becomes ADCC'B'A'A.

But, if the plane is made to move along z-direction, it will traverse a volume given by product of area and distance moved by the plane. Thus, when a rectangle ABCD is made to move perpendicular to its plane (Fig. 2), the volume of the cuboid so generated will be ABCD x distance CC' or simply [a (breadth) x b (width) x l(length)].

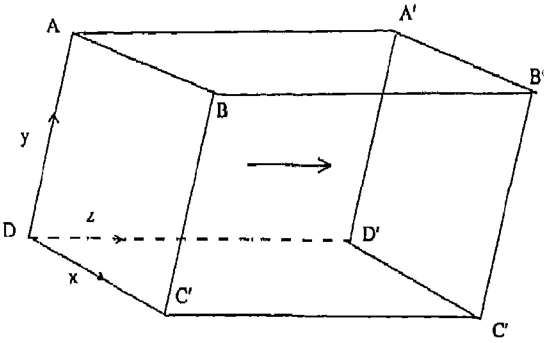

Fig. 2

Verification by known Examples

(i) Parallelopiped can be scanned by moving a plane parallelogram figure perpendicular to its surface ABCD (Fig. 3) through OO'. Hence the area is ABCD x OO' which is same as obtained by other methods.

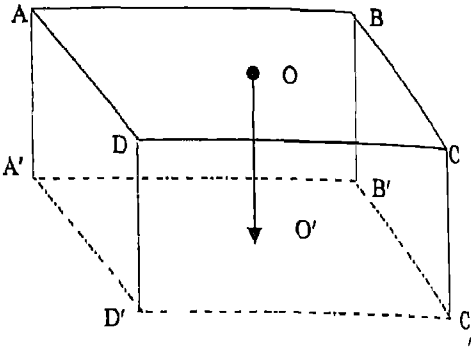

Fig. 3

(ii) A right circular solid cylinder whose area is given by $\pi r^2 l$ can be obtained by moving a disc of area πr^2 that scans a distance l perpendicular to tis plane as shown in Fig 4

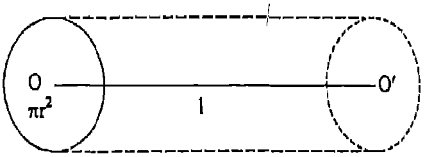

Fig. 4

Suggested Activity

Move a disc through a distance 'l' in a direction making angle θ with its normal (Fig. 5) and find out the volume that it scans. (Hint: Effective area of the disc along the direction of motion is $\pi r^2 \cos\theta$).

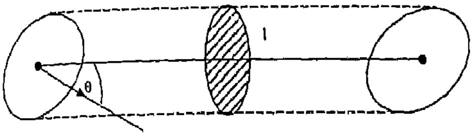

Fig. 5

Case II : When a plane rotates about an axis

Consider a rectangle ABCD rotates about AB (Fig. 6). Then its one complete rotation would scan the space that a right circular solid cylinder of length AB and radius BC would occupy i.e., $\pi(BC)^2 \times AB$

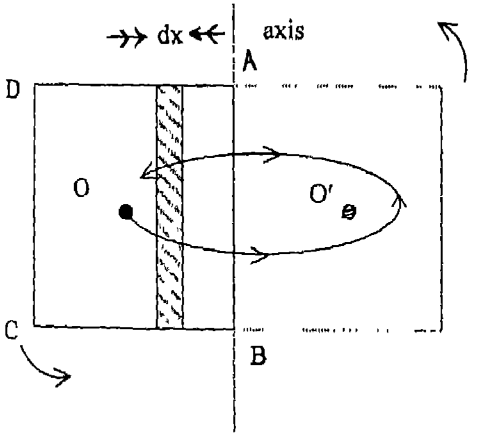

Fig. 6

Clearly the movement of rectangle ABCD is not linear. Different points on it are moving through different distances If we imagine a rectangular strip of thickness dx, it will move maximum distance if it were close to CD and it would move minimum distance if it were close to AB. It is clear that the distance moved by the strip is directly related to its distance from AB. So in such cases, we may safely choose a strip whose displacement represents average displacement of whole of the area. The average or representative location of this strip from AB is defined by

$$\frac{\text{distance of closest strip} + \text{distance of farthest strip}}{2}$$

$$= \frac{0 + CB}{2} = \frac{CB}{2}$$

This representative strip would move through $2\pi.\frac{CB}{2}$ in one rotation.

Hence the volume scanned by rectangle ABCD in one rotation

$= $ volume of right circular cylinder
$= \square ABCD \times 2\pi \times CB/2$
$= AB \times CB \times \pi \times CB$
$= \pi \times (CB)^2 \times AB$
$= \pi r^2 l$

where $CB = r$ and $AB = l$.

The result agrees with the known formula for volume of the cylinder.

Volume of a Sphere

To scan a spherical volume of radius R, we need to rotate a semi-circular disc about its diameter as shown in Fig. 7 i.e., the plane AMBOA has to be rotated about AB. If the plane is rotated through 180° it scans only a hemisphere. As suggested earlier, in the above process, each point on the semicircular disc would move through different distances. Hence we have to search for a point P normal on which would represent the area[2] (in the language of physics — we have to search for a point which represents centre of gravity of area). Then rotation of semi-circle through 180° would mean that point P is displaced to point P′. Effectively it suggests that the vector at P has to be displaced to P′ on a rotation of π.

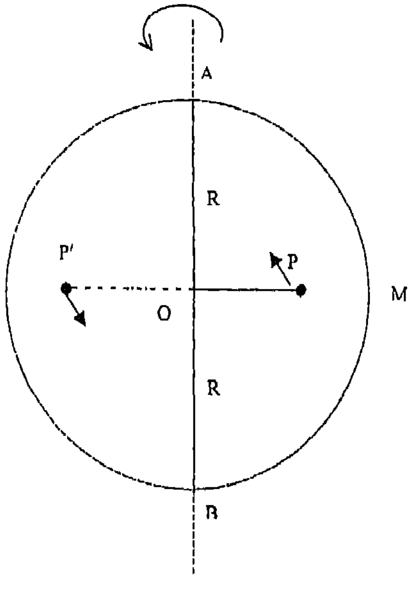

Fig. 7

But, according to definition, volume scanned by an area is equal to the product of magnitude of area and the displacement caused to it. Thus the volume of hemisphere scanned on rotating AMBOA would be given by

Area of AMBOA × Displacement pp′

$$= \frac{\pi R^2}{2} \times \text{distance } \overrightarrow{PP'} = \frac{\pi R^2}{2} \times \left(\text{distance } \overrightarrow{PO} + \text{distance } \overrightarrow{OP'} \right)$$

∴ Volume of hemisphere =

$$\frac{\pi R^2}{2} \times 2\left|\overrightarrow{PO}\right| = \pi R^2 \quad \overrightarrow{PO} \left[\because |PO| = |OP'|\right]$$

Estimation of $\overrightarrow{PO}$. If area of a surface is distributed in such a way that its magnitude *increases linearly*[3] with the distance from the axis of rotation, then there would not be much error in taking arithmetic average of distance for finding representative location of the area. But it is not so in this case (and in many practical situations). Hence one should be very careful in locating the *representative point* (to exercise what kind of average one has to take). For the present case we may proceed thus:

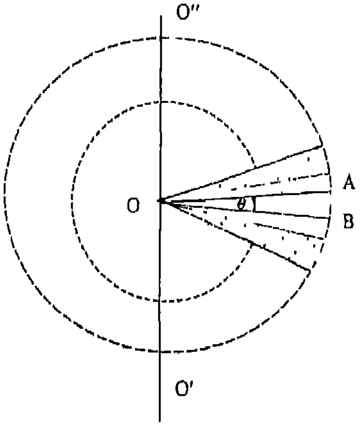

Fig. 8

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2. Point representing area is the centre of gravity concerned.
3. Linear variation suggests that if a quantity depends on distance from certain point, its magnitude should increase in proportion to the distance from point under consideration

Take a small sector subtending a very small angle θ at O (Fig. 8) If this angle θ→O, then sector OAB approximates to isosceles triangle of side R. Then the point P that would represent the area AOB will be at a distance of $\frac{2}{3}$R from O Now add equal but thin sectors to each sides of sector AOB This process, however, does not lead to a change in location of representative point of the composite sectoral area. Hence, adding such small sectors to both sides would not affect location of representative point even if we go on adding such sectors. So for the semicircular disc (which is the ultimate)

$$\vec{PO} = \frac{2}{3}R$$

Hence volume of hemisphere

$$= \pi R^2 \ \frac{2}{3}R$$

$$= \frac{2}{3}\pi R^3$$

or volume of the sphere = $\frac{4}{3}\pi R^3$

Related Activity

Let us find out the location of the representative point in quadrant of a disc when it is rotated along one of the straight edges to generate half of a hemisphere (Fig. 9).

Here area of the quadrant of a disc

$$= \frac{\pi R^2}{4}$$

Volume of half of hemisphere

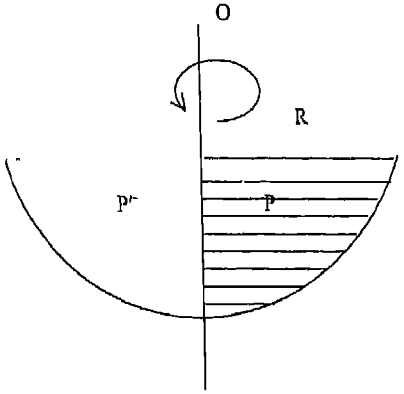

Fig. 9

$$= \frac{1}{4} \cdot \frac{4}{3}\pi R^3$$

If the distance of representative point from axis = OP,

Then the effective displacement of the area of the quadrant of the disc in the process of rotation through 180° = 2 × OP.

Hence volume scanned by it

$$= \frac{\pi R^2}{4} \times 2\ OP.$$

But according to definition, the volume of the quarter of a sphere in both cases should be the same. i.e.,

$$\frac{\pi R^2}{4} \times 2OP = \frac{1}{4}\ \frac{4}{3}\pi R^3$$

or OP = $\frac{2}{3}$R.

Hence we can say that representative point of the area of quadrant of the disc lies at a distance of $\frac{2}{3}$R Similar arguments hold for sectors of the disc which make an angle other than 90° at the centre. Hence we conclude that the location of the centre of gravity of area of a sector lies at $\frac{2}{3}R$ from centre.

Suggested Activity

(i) Take a circular disc and rotate it about its tangent. Find the volume scanned by it in one rotation (Fig 10).

Remember it will not form a sphere. Then what should be its shape?

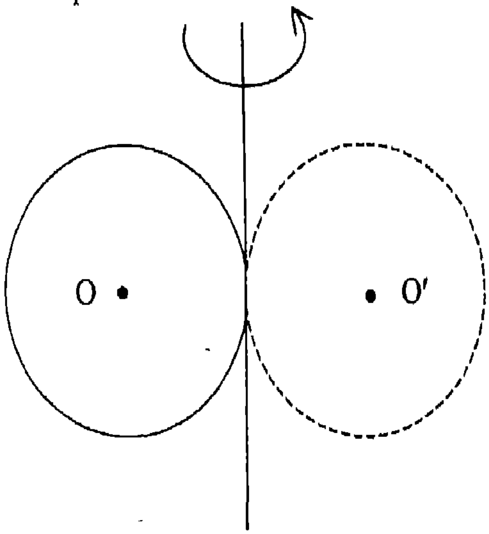

Fig. 10

(ii) Take a triangular surface and rotate it about one of its sides (Fig. 11). What shape does it scan? What can be its volume?

(iii) If a certain plane surface is rotated about an arbitrary axis, the volume scanned by it in one rotation depends on the distance of the axis from the surface. Can you imagine different shapes generated this way though finding the volume may be difficult?

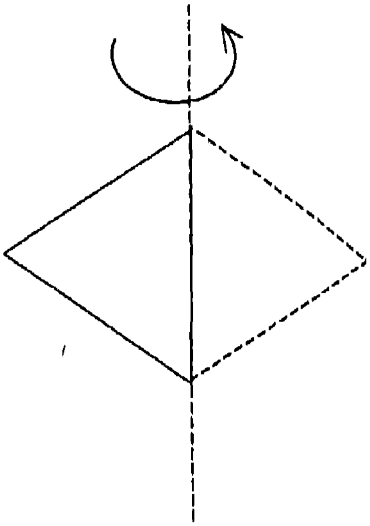

Fig. 11

Acknowledgement

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Science Education for Problem Solving and Creative Thinking: A Functional Approach

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NATIONAL Curriculum Framework for School Education developed by NCERT (2000) makes a mention that 'learning of science in school augments the spirit of enquiry, creativity and objectivity alongwith aesthetic sensibility'. Also one of the objectives for organization of curriculum at higher secondary stage has been suggested as 'to promote problem-solving abilities and creative thinking in the citizens of tomorrow'. While the first quote indicates as to what impact the learning of science can have, the second quote suggests what we should aim at while deciding the curriculum. In both the cases the common factor is the development of an attitude leading to creative thinking.

Levels of Thinking

To develop the desired attitude, training in the ways/processes required for creative thinking is essential. According to Bloom (1956) creativity is associated with divergent thinking. It is also thought in terms of personal idiosyncrasy or special competencies. Thus, creative thinking is synonym to divergent thought-processes or the competency to find unique, multiple and elaborate solutions to problems which can be solved in more than one way Wallas (1926) had suggested four-stage process as the broader aspects of human functioning viz. (i) *Preparation*, when taking every aspect into consideration all possible ways are investigated; (ii) *Incubation*, while no conscious thought or effort is done but thoughts, ideas and materials assimilated during preparation act unconsciously in the mind; (iii) *Illumination*, when some feeling or new idea comes to mind unexpectedly; and (iv) *Verification*, when the new idea is tested though the solution may or may not be in conformity with public or critic's thinking Taylor (1975) has identified the hierarchical levels of creativity given by:

(i) **Expressive creativity:** It indicates an idea different from the routine one but with no concern about its quality

(ii) **Technical creativity:** It indicates the competency in creating some product with perfectness such as a telescope, microscope etc. but involving no new idea.

(iii) **Inventive creativity:** It indicates how old things can be looked into new ways or how the existing or old materials can be used to make something new e.g , demonstrating an experiment (not given in books or other materials), how the waves can be used to produce energy.

(iv) **Innovative creativity:** It indicates the competency to formulate new schools of thought as alternatives to the traditional ones.

(v) **Emergentive creativity:** It signifies an exceptional excellence attained in abstract thinking or in the field of productivity.

To promote and attain the different levels of creativity, the function of teaching science is to develop higher levels of thinking stage by stage through a variety of questions Cognitive memory questions require students to recall essential information such as facts, definitions, formulae, rules, procedure etc. These help the students in moving one step forward towards higher levels besides assisting them in making observations using sense organs, and if needed, using instruments and then communicating them verbally. This is similar to Bloom's knowledge and comprehension level. When the students have mastery at this level, convergent thinking questions activate in using and analyzing information comparable to Bloom's application and analysis level. For example the questions like 'why does sound travel faster through solids and liquids than it does through air?' or by asking 'how can you infer the same?' help in developing basic science processes such as measuring, comparing using logic, hypothesizing, experimenting and communicating the ideas further. At this stage, divergent thinking questions stimulate the students in thinking independently. For example, the questions like 'in how many ways can the electricity be produced?' or 'How can you measure the height of a tree without climbing?' encourage the students to synthesize original and known ideas into new ones It helps them in integrating several science processes such as experimenting, inferring, predicting, hypothesizing, etc. and thereby promotes creative thinking. This level is comparable to Bloom's synthesis level. Having reached this stage, evaluative thinking questions like 'What can be the plausible solutions to solve energy crisis taking into consideration human welfare?' help students to make choices and judgements, form values, take the initiative in criticizing, defending or justifying and also in reaching sound conclusions and forming generalizations.

It is important to note here that the closed questions typified in science by those to which there is a single or unique answer or solution lead to low level of thinking through cognitive memory operations and convergent operations. Open-ended questions have no single correct answer and lead to high level of thinking through divergent thinking and evaluative thinking operations. Besides, questions based on verbal logical, visual active and visual image-thinking, requiring various tasks to be performed, help in developing divergent view of situations. Verbal logical-thinking is one of the basic types of thinking and is marked by the use of concepts and logical constructions functioning on the basis of language. For example, asking the interpretation of the rations V/I or F/m etc. is far more meaningful than merely asking the name of the physical quantity they represent. Likewise asking qualitative description followed by scientific description using scientific terminology in case of a swinging pendulum helps in making logical constructions and interpreting them verbally

Visual-active thinking is accomplished through actual physical transformation of the situation by means of an observed locomotor act. For example, after giving a network of circuit containing bulbs in series/parallel combination and asking to arrange them in such a way that the glow becomes maximum is very useful than asking to make merely series or parallel circuits using resistances.

Visual image-thinking is associated with visualizing situations and changes in them, which one will like to effect as a result of one's activity so that the transformation of situation makes general notions more concrete. For example, given the boxes with their lids closed and containing a torch bulb, a resistor, a semi-conductor diode, capacitor or nothing inside and asking the students to perform activities so as to determine which box contains what without opening the same will enable them to make generalizations more meaningful instead of merely asking as to how the resistance or the capacitance behaves with the application of supply voltage. Also a distinction should be made between intuitive and analytical or logical thinking. The example can be: A tank filled with 20 litres of water is emptied in 10 minutes through a tap at the lower end of the tank. How much time will be taken to empty this tank if (i) it contains 40 litres of water? and (ii) the dimensions of the tank are so changed that it contains 40 litres of water up to the same initial height?

Such problems will help the learners to infer that intuitive thinking is characterized by the speed of the process, lacks clearly defined stages and has minimal degree of awareness. Thereby they will realize the importance of analytical thinking, which evolves with time, has clearly defined stages and is expressed with thinker's consciousness to a considerable degree.

Review of Studies

Manifestation of creative abilities is evident when one is proficient in problem solving. Review of studies indicate the following salient features pertaining to abilities for problem solving.

i. Mere knowledge in cognitive memory does not mean that it will be available at the time of problem solving (Perfetto et al 1983). Adequate organisation of knowledge in memory increases the availability of knowledge In other words, a suitable cognitive structure plays a significant role in problem solving. It is supported by studies in different domains such as mechanics (McDermott 1984, Halloun and Hestanes 1985), electric circuits (Shaffer and McDermott, 1992, Mc-Dermott and Shaffer, 1992) which show that the experts possess hierarchically organised integrated knowledge structures

ii. Novices, in general, use formulae centred problem-solving methods

(Heller and Reif, 1984, Halloun and Hastenes, 1985, Larkin et al, 1980) and see problems in terms of objects and terminology e.g. spring, pulley, string, atom, molecule etc. Experienced physicists see the problems in terms of concepts (Chi et al, 1981, 1982 Dufresene et al, 1987, Eylon and Reif, 1984, De Jong, Monica and Hessler, 1986).

iii. Knowledge structure of novices in physics appears to be amorphous and based on surface features instead of global themes and underlying conceptual frameworks (Larkin et al, 1980, Reif, 1995). Experts characterize the problems on the basis of fundamental and deeper structure (i.e , the principles and concepts that could be applied to solve the problem) as the classification criterion (Chi, Feltovich and Glaser, 1981, Hardiman, Dufresne and Mestre, 1989, Schoenfeld and Herrmann, 1982). Besides, the experts e.g. university professors use working forward strategy (Chi and Bossok, 1988, Dufresne et al, 1987) as against means ends analysis strategy (Ayres, 1993, Larkin, 1983, Owen and Sweller, 1985, Sweller, 1988). To use the same, one begins with the current information given in the problem statement and works forwards – performing operations based on concepts to transform it until the goal is achieved Non-experts adopt working backward approach, which involves the use of specific formulae or algorithmic procedures given by a set of defined steps with little understanding (Chi et al, 1981, Gabel, Sherwood and Enochs, 1984, Schoenfeld, 1985).

iv. After classification of the initial problem, an expert generally performs the qualitative analysis of the problem This leads him to consider scientific description involving principles or concepts to be made use of so as to attack the solution of the problem. Then he executes the strategy Novices, on the other hand, try to reduce the distance between the initial-state and the goal-state by manipulating equations until the desired quantity is isolated. This involves means-ends analysis and is a backward reasoning.

v. Phases of problem solving have been identified (Mandall, 1980) as follows:

(a) Initial attack phase, which in other words (Wicklegren, 1974) means cataloging the 'givens, operations, goals'.

(b) Follow up phase described as hypothesis formation-phase or the creative-phase of Rogers, 1962.

(c) Incubation phase identified as testing hypothesis or the checking stage of Rogers, 1962.

(d) Solution phase, which can be considered as stating the conclusions.

vi. Studies suggest that 'modelling' can also enhance problem-solving ability (Ausbel, 1963, Bodner, 1987, Frank et al, 1987, Gendell, 1987, Gilbert, 1980, Perkins, 1987, Reif, 1983 and Zoller, 1987). In this technique, either the sample problems are solved or thought processes are verbalized involving students as the teacher solves the problems in the class (Kolz and Snyder, 1982, Woods, 1989, 1990). It implies that expert modelling will lead the students in developing thought processes as well as the mechanical processes for problem-solving ability

Strategies to Develop Creative Problem Solving Ability

It is thus evident that problem solving requires thinking or gap crossing. Simply applying or using a set procedure known as algorithm technique is not sufficient Giving a set of rules or procedures to the students means that we are doing the thinking for them and absolving them from the responsibility of thinking. Problem-solving capability has to be developed through active intellectual engagement and independent thinking and not just through passive observation.

It has been suggested (Nickerson et al, 1985) that some problems are unlikely to be solved at all without some inventiveness. The instructional literature nevertheless recommends several strategies to help students integrate the conceptual and procedural aspects of problem solving. Heller et al, (1992) have suggested the following five-step strategy based on their work (1984) and Schoenfeld, (1985):

I. *Visualising the problem:* It requires the translation of the problem statement into a visual and verbal understanding of the problem situation so as to facilitate subsequent solution. Drawing a diagram and identification of the data are thus the requisites to decide the principles applicable to any solution for the next step.

II. *Giving the scientific description·* This step requires students to use their qualitative understanding of the concepts and principles to analyse and represent the problem in scientific terms.

III. *Planning the solution:* Under this step, scientific description is to be translated into an appropriate mathematical representation of the problem. This will involve equations of principles and constraints besides determining if enough information has been represented which is needed to solve the problem. Then algebraic procedure has to be decided to solve the unknown(s).

IV. *Executing the plan:* Mathematical rules are to be used to obtain an expression with the unknown variable on one side of the equation and known quantities on the other side. On substituting the values, numerical solution is then found.

V *Checking and evaluating the result*: This last step is used to evaluate the correctness of answer by checking the sign and units besides using the experience of the world regarding expectations of how large or small the numerical answer should be.

Example

An astronaut on a planet has at his disposal a thin thread of known length, a small weight and a stopwatch. Having known the length of the equator of the planet, how can he determine the mass of the planet?

Solution

1 Qualitative Description

Visualizing the problem:

(a) Identify what is given in the problem.

Following quantities are to be considered as known

(i) Thread of known length

(ii) Small weight

(iii) Stopwatch for recording the time

(iv) length of the equator of the planet

(b) Identify what is to be determined.

Mass of the planet is to be determined

2. Scientific Description

Making a simple pendulum by using the thread of known length and weight of a given value, measurement of time for known number of oscillations with the help of stopwatch can be done. With the help of the formula for time period of a simple pendulum 'g' can be determined.

'g' can also be determined using Newton's law of gravitation. Comparing the abvoe two relations, mass of the planet can be determined.

3. Planning the Solution

(i) What is the relationship between L, T and g?

(ii) How the above-determined value of g will be related to Newton's law of gravitation.

(iii) Equate the two values and write the value of R in terms of equator of the planet

4 Executing the Plan

$T = 2\pi\sqrt{L/g}$

Or $g = 4\pi^2L/T^2$

$g = G\,M/R^2$

Therefore: $4\pi^2L/T^2 = GM/R^2$

$R = C/2\pi$

Therefore: $M = 4\pi^2R^2L/GT^2$

$= C^2L/GT^2$

5. Checking the Results

Since C, L and T are now known and G is a universal constant, M can be determined.

While different steps as a part of strategy for problem solving have been suggested, different protocols/modes are used to know students' thinking during the course of solving the problems. These include:

(i) Asking each student to think aloud to know the way of thinking (Mandle, 1980, Zajchowski and Martin, 1993).

(ii) Thinking aloud pair problem-solving (Pestel, 1993, Whimey, 1984 and Woods, 1989). In this method one student is asked to work the problem with the partner who does not directly participate in solving the problem but forces the problem solver to verbalise all thought processes and justify the procedure, manipulations and use of all the principles involved in the solution.

(iii) Co-operative group problem-solving (Heller, Keith and Anderson, 1992). Students share their conceptual and procedural knowledge as they solve a problem together Each of them can ask and justify the explanation from any other. Mutual criticism is seen to help and clarify all members' thinking.

(iv) Qualitative problem solving strategy (Leonard, Dufresne and Mestre 1996). It includes a qualitative description of the major principle(s) or concept(s) that can be applied to solve the problem, justification for the same and the procedure by which these can be applied to arrive at the solution

Thus, different strategies and their use in different ways have been suggested for problem-solving and their use are seen to lead to development of abilities required for creative thinking The abilities as identified by Guilford, (1975) include fluency, flexibility, originality and elaboration. In the context of teaching science they have significant meanings Ideational fluency is considered to having been achieved if the learners are able to write titles/words based on scientific principles for the explanation and imagine many consequences in case of change in conditions or physical situations. Associational fluency includes the ability to determine relationship using figures, symbols, data, equations, interpretations etc. for the given situations. Expressional fluency includes the ability to provide connections to the missing link(s) based on scientific principles so as to give the full explanation of any event/phenomena. The ability of flexibility pertaining to creative thinking is observable when the learners construct as well as reconstruct their own ideas based on scientific reasoning. Choice of suitable questions at synthesis level can further stimulate the learners to consider variety, new ideas or original possibilities in an integrated manner for creative behaviour To promote originality amongst the learners the teachers have to challenge pupils' ideas, questions and answers in a democratic manner and provide opportunities for the same to them. Elaboration indicates the ability to explain the major as well as minor details pertaining to subject matter without any doubt.

To cultivate creative problem

solving habits for developing the above four abilities a five-step process suggested by Osborn, (1963) is very helpful It includes— (1) searching a problem taking into consideration different perspectives so that a real challenge and stimulation is there for finding out the solution; (ii) finding out facts so as to understand inherent conditions, situations etc before making a decision for any plausible solution ; (iii) finding out the ideas consciously as well as subconsciously so that all the ideas are flushed out before any judgement is taken to attack the problem; (iv) finding out the solution taking into account all the ideas, their relevance and applicability and finally; (v) finding the acceptance of the solution which can gain support for its practical use.

Implications

Thus, while thinking has many facets such as verbal logical, visual active, visual image and others, creative thinking is manifested by characteristics such as fluency, flexibility, originality and elaboration which can be cultivated using suitable strategies. To be proficient enough in various types of thinking helpful for creative problem-solving, critical thinking is required which in turn means acquisition of various competencies (Jain 1996, 2000) such as understanding the nature of the problems, comprehending the ideas contained in the problems, use of mathematical skills, analysis of the concepts based on scientific principles and integrating them by constructing and reconstructing the ideas, use of idealisation to make solutions plausible besides adhering to the line of reasoning etc. till the solution is obtained While solving the problems of different types, though these competencies are necessary, yet a positive attitude, confidence and other general qualities listed below play a great role in equipping the learners for developing creative behaviour for problem-solving.

(1) Sensitivity to notice and detect the missing information and anomalies in the given situation

(2) Curiosity to observe, explore and toy with different ideas

(3) Imaginative to visualize about any event/phenomena

(4) Independent thinking to make decisions

(5) Tolerance for divergent opinions

(6) Courage to take risk even if results are not forthcoming and at the same time observing precautions

(7) Quest for an order out of complex situation

(8) Readiness to improvise with limited resources

(9) Ready to reconstruct views

(10) Readiness to defer judgement in view of insufficient evidence.

It is, therefore, necessary that the teachers should realize that problem-solving and, in particular, creative problem solving do not automatically follow their instruction in the classroom. Rather they should use appropriate strategies depending upon the variety of problems. The strategies may include verbal interpretations, qualitative descriptions of any event of phenomena in scientific words, reversal of the line of thought, explaining the ideas before giving any scientific name, looking the causation patterns, searching the line of reasoning using algebra, arithmetic, diagrams and graphs, serialization and comparing the available information, constructing and reconstructing the ideas through acceptance or rejection, forcing the learners to take decisions using accepted as well as off-beat ideas leading to original thinking, asking them to integrate observations with experiment and theory and so on. In doing so, he/she may opt for paying attention to individuals or by forming pairs or groups and asking the students to think aloud or asking them to write in their own style or asking them to question each other and organize brain storming sessions depending upon the nature of the problem. Also the teachers should create such an atmosphere in the classroom where there is always a scope for flushing out the ideas indicating independent thinking and the learners have a desire for problem-solving.

Lastly, though problem-solving is considered to be the core life skill, it is well known that the students get minimum opportunity through the usual lectures, and text reading etc. Also, even if a few students are able to acquire this skill, the process of reaching to that stage tends to be very slow. In this context, strategies suggested above should be useful to the learners in different context-rich courses at school level and in their future courses and careers.

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How the Teachers in Ashram Schools Perceive Science Curriculum at Upper Primary Stage

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The tribal population in the state of Maharashtra is about 10 percent of the total population. They are clustered in three traditional regions: Sahyadri, Satpura and Gondvan. Tribal Development Department of the Government of Maharashtra has established adequate number of Ashram schools to facilitate the education of tribal children in each of these regions After the initial reluctance from tribal communities the enrolment in these schools has improved considerably. Nevertheless, because of lack of tradition of education in their homes, learning of formal school subjects remains a Herculean task for the students Teachers are expected to make an extra effort to facilitate learning of technical subjects like science and mathematics In order that they do their job well, they need to have proper perception of the subject as well as of the difficulties faced by the students. What is the perception of teachers related to the aims and objectives of science curriculum? What are the learning difficulties of students and how to facilitate better concept formation in science? What modifications the present evaluation methods demand to assess the knowledge and skills acquired by the students? These are crucial questions and demand for critical exploration.

As a part of its manifold activities the Homi Bhabha Centre for Science Education (HBCSE) conducts in-service training of science and mathematics teachers. Because of its interest in the education of socially disadvantaged students HBCSE has been interacting with Ashram school system for about seven years It had arranged training courses for teachers teaching science and mathematics to grades IX and X in Post-basic Ashram schools. While interacting with students at secondary level it was observed that many of them had poor initial preparation. This observation brought out the need to improve teaching at the upper primary stage (classes VI to VIII). Accordingly, in-service training programmes for the teachers teaching in upper primary classes have been initiated for the academic year 2002-03. In order to assess the needs of practising teachers an attempt was made to understand their perception about the curriculum, areas of difficulty, ways and means to overcome the difficulties, suitability of evaluation methods, etc. This paper describes the design of the study, data collection, their analysis and implications.

Designing a Questionnaire and Data Collection

The researchers had an opportunity to interact with about 60 teachers dealing with students at the upper primary classes during a training course arranged for Ashram school teachers. This opportunity was used to identify crucial issues related to the teaching of science in their schools by forming six groups from among the participants. The leader of the each group was expected to present the summary of the deliberations. The presentations brought out the urgency to tackle issues related to the suitability of school curriculum, teacher pupil interaction, remedial teaching for tribal children, etc. Based on these inputs a questionnaire was framed to get the opinions of practising teachers on teaching objectives, students' difficulties, validity of evaluation techniques, etc. It had following seven questions:

1. What do you think are the aims and objectives of teaching science at upper primary stage?
2. Which concepts do the students in your classrooms find difficult?
3. In your opinion what are the causes of the difficulty?
4. What do you do to overcome these problems?
5. What is your opinion about the present method of evaluation used to assess the students' understanding?
6. What modifications do you suggest in the evaluation procedure?
7. Taking into account the needs of the country and the requirements of tribal population what changes do you recommend in the school science curriculum?

After each question enough blank space was provided for teachers to express their opinions in detail. They were encouraged to use additional sheet if required. The sample for the study consisted of 57 teachers who participated in yet another training camp of HBCSE. They were from 57 different schools in Thane, Pune and Raigad districts of the state of Maharashtra. The students to whom they cater to, come from communities living in the Sahyadri ranges of the state. This region inhabits the communities like Warli, Katkari, Kokna, Mahadev Koli, Malhar Koli, Dhor Koli, Thakar, etc. All these castes are categorised as the Scheduled Tribes (S.T.) and are given facilities as per the norms of the State and Central Government.

Traditionally, in the state of Maharashtra, Classes V to VII are considered to be the part of upper primary stage and Class VIII is attached to secondary schools. The basic Ashram schools with upper primary classes terminate at Class VII The sample of teachers included in the study, therefore, consisted of teachers teaching Class V to VII. They had Higher Secondary School Certificate (H S.S.C) along with a Diploma in Education (D.Ed.). Most of the teachers were new to the profession with 1-5 years of teaching experience. Of the 57 teachers who filled the questionnaire 39 were males and 18 were females. Since teachers are expected to live within the campus of the schools, female teachers are usually reluctant to accept the job in Ashram schools. However, with special drive to get female teachers at the primary level some of the Ashram schools could appoint good number of them.

Data Analyses and Discussion

All the seven questions included in the questionnaire were analysed separately. The salient findings of the analyses are presented in this section.

Responses to Question 1

Teachers were expected to list the aims of science education they considered important at the upper primary stage. It has been found that teachers usually expressed more than one aim. The analysis of the data is shown in Table 1. From the table it can be seen that a large number of teachers consider developing scientific temper as the most important objective of science teaching. Attempts were made during the course to explore if the teachers really understood the meaning of this phrase. Surprisingly, only a few had a clear understanding of what the phrase really means and what is expected when one aims at developing "scientific temper".

TABLE 1

Aims of science education at upper primary stage

Aims	*Number of teachers*	*Percentage*
Developing scientific temper among the students	36	63.15
Understanding incidences occuring in the vicinity	30	52.62
Creating interest towards science	26	45.61
Bringing out social development	23	40.35
Developing science related competencies	21	36.84
Preparing students to deal with future problems	15	26.31
Explanation of some simple concepts in science	12	21.05
Developing experimental skills	11	19.29

The second aim referred to by a majority of teachers is to help pupils understand the incidences and happenings in their vicinity. Teachers think that this aim is important for the tribal students as many of them are under the influence of superstitions prevailing in their society The lack of understanding of cause-effect relationship usually forces people to believe that there is some mysterious power behind it. Most of the teachers displayed the concern of the removal of wrong beliefs possessed by the students. They felt that teaching of science would enable them to think rationally and explore cause-effect relationships behind everyday occurrences.

A little less than half of the teachers (26) believe that the aim of the teaching science at the upper primary stage is to create interest among the students towards science. It is hoped that positive attitude towards science might motivate them to undertake higher studies in science and to pursue career related to science Teachers were aware of the need for adequate number of scientists and technocrats for the country. They were also concerned that the tribal communities are grossly under-represented in these professions. They were, however, optimistic that with special efforts this picture can be changed.

Social upliftment was considered to be an important aim of science education by 23 teachers. They were more concerned with the improvement of the status of tribal communities. They believed that learning of science would bring about social development by enabling these communities to adopt hygienic practices, by making use of resources properly and by adopting appropriate methods of cultivation A small number of teachers view teaching of science as a vehicle to bring out the relation between science and social development. Although teachers look at the science curriculum as a means of achieving these objectives, many of them have a feeling that the present content is inadequate to fulfil these demands.

In the recent past, focus of teaching science has shifted from information sharing to developing science related competencies. A programme on competence-based teaching has already been launched in the country for the primary grades. Some teachers (1) are influenced by this thinking and envisage development of these competencies as the main aim of teaching science even at the upper primary stage. The competencies involved are the development of curiosity, skill of observations, ability to draw inference, etc.

Preparing children for their future is considered an aim of science education by 15 teachers. The term 'future' has two connotations· preparing for further studies and preparing for good citizenship. Learning of science at the upper primary stage is expected to prepare student to deal with high school science without any difficulty. In addition, learning of science is expected to prepare them to face challenges in the future. Further explorations, however, showed that teachers' understanding of 'good citizen' was unclear

A dozen of teachers opine that teaching of scientific concepts discussed in the respective textbooks is the necessary task. Teachers should ensure that students have a proper concept formation. Good understanding of textual material would enable them to score better in the examinations This success is expected to motivate children to read science based material from newspapers and magazines and get enriched.

A small number of teachers (11) view developing experimental skills as an important aim of science teaching. Students with rural background are usually well prepared to work with hands. However, when it comes to handling laboratory instruments these students commit mistakes. These teachers opined that science teaching should aim at providing adequate practice to enable the students to acquire necessary laboratory skills. Acquisition of the skills, they believed, would hopefully develop confidence among the students.

Responses to Questions 2, 3 and 4

Questions 2, 3 and 4 focussed on students' difficulties, their causes and possible remedial measures Because they were closely related to each other, the analysis of responses to all the three questions is presented in one section As a response to question 2, teachers were expected to list the concepts from the syllabus of grades V, VI and VII that are found difficult by a majority of students in the classroom. Since most of the teachers had the experience of teaching science to all these classes or to at least one of these classes, they could supply a considerably long list of concepts. Looking at the list one finds that they can be classified under three categories:

1. Concepts involving symbols/ formulae: Teachers reported that the concepts involving symbols and formulae are found difficult by a majority of students. For example, when the concept of density is described as ratio between mass and volume (m/v) students are unable to know what it means. It might be because students are not familiar with the symbolic language in science.
2. Concepts that cannot be shown: In the opinion of teachers the concepts are found difficult if they cannot be shown or demonstrated by an activity/experiment Examples in this category are: Photosynthesis, Atomicity, gravitation, digestion, etc Lack of direct experience adds to the abstract nature of the concept
3. Concepts devoid of daily relationships: If the concept has no relation to the daily lives of students, they find it difficult to understand. Concepts in this category are. catalysis, tides, function of a cell, etc. Since they find no relevance they are not motivated to learn.

Why do students find it difficult to deal with above types of concepts? Question 3 sought for teachers' views on this issue. In addition to listing difficulties associated with specific type of concepts, teachers attempted to mention general difficulties faced by the students in science education. The analysis of the data, thus obtained, is presented in Table 2.

The analysis showed that teachers find unfamiliar language as the single most important area of difficulty. It would be proper to discuss what sort of linguistic difficulties students encounter Textbook of science makes use of technical terms derived usually from Sanskrit. Students are unable to decode the meanings of these terms (Agarkar, 1985). Although science textbook is written in Marathi (the official language of the state of Maharashtra) the nature of language spoken by the tribal communities is often different from that used in school textbooks. Teachers too, are tempted to use textual language in classroom discourse making teacher pupil interaction non-productive, as the students prefer to keep silent when they find the language unpalatable to them.

The second culprit in the eyes of teachers is the poor initial preparation on the part of students Teachers felt that because of poor learning skills, students were unable to handle involved concepts On the affective side, teachers felt that students were ill motivated to struggle until mastery in learning was achieved. Thus, inadequate cognitive entry behaviour as well as improper affective entry characteristics were responsible for poor concept formation among the students.

In the views of an appreciable number of teachers (19) it is the lack of facilities in schools that is to be blamed. The laboratory facilities in schools are so meagre that activity based teaching can hardly be undertaken. Apart from teaching school subjects, the Ashram schools have the responsibility of providing educational opportunities. In this regard the teachers felt that·the situation is far from satisfactory. Since the schools are located in remote areas, opportunities like public lectures and public library are almost non-existent in their vicinity. Electronic media like radio and television have made a great headway in recent years. These facilities are, however, not available to the students Lack of proper educational opportunities, in the eyes of teachers, hinders the fixation of knowledge gained in school classrooms.

Although most of the teachers have blamed school system, a small number (11) hold teachers responsible for the lack of students' understanding. Bad teaching, in their opinion is the main cause of poor learning They felt that many teachers do not have clear understanding of the aims and objectives of science curriculum. Some of them were themselves poor in content knowledge with a large number of unsolved questions and doubts in their minds. Since there is no mechanism where teachers can receive guidance, they continue to teach badly without ensuring the comprehension on the part of the learners.

Non-conducive home environment of the students is said to be the cause of poor learning by 10 teachers. In their opinion, the home environment, being deprived in a variety of ways, does not

TABLE 2

Causes of difficulty

Nature of difficulty	*Number of teachers*	*Percentage*
Linguistic difficulties	25	43 85
Poor initial preparation	22	38 59
Lack of facilities in schools	19	33.33
Lack of educational opportunities	11	19 29
Improper teaching method	11	19.29
Non conducive home environment	10	17.54
Conceptual difficulties	07	12.28

provide any motivation to the students to learn science seriously. The educational status of members in the society is such that it fails to provide relevant academic inputs or to satisfy the curiosity aroused in the minds of children.

Are the concepts within the reach of students? A few teachers (7) feel that the difficulty level of some of the concepts is so high that students are not prepared to cope with them Some of these teachers even went further to state that students from deprived homes have a lower I.Q. and hence are incapable of dealing with involved abstract concepts. These teachers need to re-look at their belief system

Related to various educational problems question 4 attempted to seek information from teachers about special efforts that they make to help children learn difficult concepts. Barring a few who left the question blank, a majority had mentioned what they do within and outside classrooms. The nature of efforts made by teachers can be conveniently categorised as shown in Table 3.

The large number of efforts are concerned with activities/experiments In the opinion of teachers it is the abstractness of the concept that makes it difficult to understand. This abstractness can be removed by performing suitable activities. Even though many (41) have said that they resort to laboratory programme, it must be noted that it is mostly of demonstration type. Students are hardly given an opportunity for hands on activities (Agarkar, et al. 1997).

Since language difficulty was considered to be the main hurdle in learning science, teachers (29) seem to take care of this difficulty very seriously. On one hand they try to familiarize students with the formal language by giving reading assignments to the students. To achieve a little fun in this assignment, some teachers even arrange blind games of picking up sheets to decide who should read On the other hand, teachers attempt to simplify the language of the textbook by providing meanings of technical terms and using colloquial language in the classroom.

A substantial number of teachers (14) stated that they resort to giving examples and anecdotes to clarify science concepts. Science textbooks

TABLE 3

Efforts by teachers

Nature of efforts	*Number of teachers*	*Percentage*
Emphasis on experimentation	41	71.92
Language simplification	29	50.87
Example and anecdotes	14	24.56
Enhancing pupil participation	13	22.80
Outdoor activities	09	15.78
Question-answer and revision	07	12 28

attempt to provide some relevant examples and anecdotes. However, since they are prepared centrally for the use by schools in the entire state, examples cited in the book are seldom relevant to the lives of students. In such a situation teachers have to look for life-related examples. This is certainly a challenging task that is undertaken by only a small number of teachers.

A group of teachers (13) struggled to enhance pupils' participation in the classroom. Due to fear of committing mistakes, students prefer to remain passive in the classroom. Many of them are afraid of the punishment that the teacher might give if they do something wrong. It is a matter of concern and skill to make students actively participate in the classroom deliberations. It is heartening to note that a small number of teachers strive to achieve this goal.

A few teachers (9) have said that they focus on arranging outdoor activities. Because of the scenic location of the schools, students have a good scope for nature study. Some of the teachers make use of this opportunity by arranging outdoor activities. In their opinions, outdoor exposure is as important as classroom interaction as it provides opportunities for experiential learning among the students. By some (7), however, dealing with student's questions sympathetically is seen as a solution to overcome students' problems. Since the time available in the classroom is not enough to deal with students' questions, these teachers usually arrange separate question-answer sessions during the free time of the students

Responses to Questions 5 and 6

These questions were framed to get teachers' opinions about the present mode of evaluation and to seek their suggestions for modifications. Nine teachers did not attempt to respond to these questions. Of the remaining, roughly half of the teachers felt that the present method of evaluation is proper while the other half opined that it is grossly inadequate. It would be informative to inquire why these teachers feel the way they do. Let us look at the arguments made by the teachers who felt that the present mode of evaluation is appropriate. Some of the reasons given by them are as follows: -

1. It helps us to discriminate who have acquired concepts and who have not.
2. It enables us to understand the lacunae in the conceptual understanding of the students so that the difficult portion can be revised.
3. It provides an opportunity to the students for written communications and facilitates teachers to know who can express their knowledge properly in the written mode.
4. Since students are expected to remember information for examinations, it helps to develop the skill of memorisation.
5. Examinations arranged at regular intervals of time prompt the students to revise the matter and keep themselves up-to-date.

Why do many teachers think that the present mode of evaluation is not proper? In their opinions it has the following drawbacks.

1. It focuses only on the written mode of communication. Those who are unable to express properly in written mode are at loss.
2. It encourages mugging up of the information without understanding. Good score in the examinations is often wrongly equated with good understanding of the subject.
3. It does not test the skills like keen observation, handling of instruments, ability to draw inference from the data, ability to use information in daily life, etc.
4. It puts undue emphasis on objective testing and hence students usually avoid going deep into the matter.
5. The question papers are usually same for urban as well as for rural children. Rural children are at loss as they have different domain of experience and different level of linguistic competence.

Teachers were asked to make suggestions for the improvement of the present mode of evaluation. Their responses belonged to three different categories The first category of teachers (19) comprised of those who stated that present mode of evaluation is appropriate and needs no modification The second category comprised those who felt that the evaluation methods is generally acceptable but desires some modifications (06). The last category of teachers (23) consisted of those who felt that the present method is grossly inadequate and needs drastic changes. Suggestion made by second and third category of teachers can be classified as shown in Table 4.

A majority of teachers suggested that teacher-made test should be given importance A little explanation is required to appreciate the concern expressed in this suggestion. In order to keep pace with other schools, the Tribal Development Department acquires and uses tests made by other educational institutions for the terminal examinations of Ashram schools. Teachers feel that those tests are framed taking urban middle class students into

TABLE 4

Suggestions for improvement in mode of evaluation

Category of suggestions	*Number of teachers*	*Percentage*
Within class evaluation	16	33.33
Use of experiments/activities	15	31.25
Diagnostic testing	14	29.16
Based on experiences	09	18 75
Style of questioning	03	06 25
Testing of personality traits	03	06.25

account. Some teachers (3) even felt that the language and the style of questions are unsuitable for the students coming from tribal homes. Due to the common mode of testing students, they felt that their students often performed at a lower level than they deserved. Hence, teachers advocated that testing should be entrusted to the teaching community of the Ashram-school system.

As mentioned above, many of the teachers (15) were worried that the school testing neglects evaluation of experimental skills at the upper primary level even though practical examinations are conducted at school leaving stage. In their opinions, due importance should be given to the laboratory programme both in teaching and in assessment. Activity based assessment would enable the teachers to not only assess students, laboratory skills but also to find out if students can make use of scientific knowledge in practical set up. Along with laboratory testing, a small number of teachers (3) even went further to suggest that personality traits should be assessed.

Appreciable number of teachers (14) suggested that diagnostic tests should be prepared and used frequently to assess the lacunae in pupils' understanding. Such a test should be administered soon after the completion of the unit in the classroom. Ashram schools cater to a special group of students. Their home background and the nature of experiences are very much different from the other students. The testing that assumes a normal classroom interaction is not suitable to these students. Hence, teachers (9) suggested that the tests should be prepared taking into account the nature of experiences the students have.

Responses to Question 7

Teachers were asked to offer suggestions of the modifications in science curriculum at upper primary stage taking into account the needs of the country and of the community the Ashram schools serve. Only a small number of teachers could make suggestions taking into account the needs of the country. All those suggestions refer only to the teaching of information technology. They were,

TABLE 5

Suggestions for curriculum modifications

Nature of suggestion	*Number of teachers*	*Percentage*
Inclusion of content useful for social development	24	42.10
Style of presentation in the text book	19	33.33
Bringing out relation to daily life	15	26.32
Opportunities to develop competence	06	10.52

however, not clear as to what extent it should be taught to the students. Many of the teachers felt that they have no authority and experience to think of national level policy. They (52) could, however, make suggestions taking into account the requirements of the students, as they have been interacting with them day in and day out. Some of the suggestions made by the teachers are mentioned in Table 5.

In the opinion of a large number of teachers, the textbook is the most important instructional material used in school teaching. The content and the style of textbook influences not only classroom interaction but also learning of the subject. They, therefore, recommended that the textbooks should be modified suitably to facilitate learning of science among Ashram school students. The tribal communities are usually dependent on the forest products and agriculture for their livelihood. It should be useful if the science curriculum provides them guidelines to make use of their resources optimally. Lack of hygienic habits is another problem worth reckoning. It would be desirable if science curriculum attempts to tackle this issue Because of the isolation from the mainstream, many of the communities are still unfamiliar with the recent technological developments. An attempt to acquaint them with the modern technology and equipping them to use the technology for their benefits would also be welcome.

Apart from the choice of the content, the teachers (19) have specific suggestions for the style of textbook presentations. Firstly, all of them have recommended that it should be written in a simple language palatable to the students coming from tribal homes. Secondly, it should have adequate number of examples and anecdotes to explain involved concepts Thirdly, it should provide sufficient number of activities that can be easily performed in the schools. Lastly, it should suggest model questions to assess conceptual understanding of students.

In addition to changes in curriculum and textbook preparation, a substantial number of teachers have made suggestions for the change in teaching style There were two specific suggestions made by the teachers. The first suggestion refers to relating science to daily lives of students In order that students are motivated to learn the concepts in science, teachers suggested that the relevance, of the content should be brought out clearly. To achieve this goal, teachers will have to make special efforts. Since the textbooks are written centrally, it will not be possible to refer to diverse experiences within the textbook itself. It would be the duty of a teacher to look for appropriate experiences and examples to illustrate or explain the concept at hand.

In the teaching of science many teachers equate transfer of scientific information to the teaching of science. One of the main aims of teaching is the development of skills pertaining to scientific pursuit. Along with teaching of science, one needs to take into account teaching through science (Shayer & Adey, 1981). Some of the teachers have realised this need and hence suggested modification in the classroom interaction to put emphasis on skill development In addition to providing opportunities in the classrooms, some teachers feel that deliberate efforts be made to provide out of classroom opportunities for learning and fixation of knowledge (Kawathekar & Agarkar, 2002).

Conclusions and Implications

The Study referred to in the paper was conducted on a sample of teachers drawn from Ashram schools in Sahyadri ranges. There are a large number of such schools catering to rural population in the country. The study has raised issues related to curriculum, teacher preparation, assessment techniques, school facilities, etc All these issues are important as far as the teaching of science in Indian schools is concerned and need to be looked critically.

Framing of School Curriculum

Education is on the concurrent list of the state as well as of the Central Government. The main responsibility of framing curriculum falls on the central agency (National Council of Educational Research and Training). It usually makes available the framework of curriculum and sample textbooks for the consideration of the state Governments. Some of the state governments accept the curriculum as it is, while some others adopt it to suit the needs of their population The study brings out the fact that requirements of the tribal population are very much different from other population and this aspect must be taken into account while framing the curriculum. Rural people look at education with great aspirations to change their lifestyle Some of them view education as a tool to remove superstitions; some view it as a means to provide bread and butter while some others look at it as a route to proper utilization of resources. In the centralised mode of curriculum framing, all these aspects might not get reflected. These changes will have to be made at local level.

Teacher Preparation

In India, prospective teachers are expected to undergo training in education At the upper primary level, teachers usually have Diploma in Education (D.Ed.) It provides general background for the teaching, taking into account the contemporary knowledge in educational psychology. It, however, does not prepare teachers to handle the special group of students like the one being considered in this paper. In the absence of understanding of the difficulties these students face, many teachers hurriedly conclude that the students have a lower Intelligence Quotient (I.Q). As a result, these teachers are so pessimistic that they go to the extent of making statement–"No change will bring these students into the mainstream" There is, therefore an urgent need to change the attitude of teachers towards the educability of tribal students.

Moreover, there is always a change in the content of the subjects they are expected to teach. In case of science, the changes are prominent forcing teachers to deal with concept that he/she might have not studied during their school days. This brings out the urgent need for the in-service training of teachers. It has been found in many field programmes of the HBCSE that teachers demand for inputs in content as well as in pedagogy (Agarkar, *et. al.* 1997)

Educational Opportunities for Students

The school system referred to in this paper caters to a special group of communities that hardly provide suitable home background to undertake academic activities. Schools are expected to provide opportunities to compensate for this deprivation. Fortunately, there is a scope for undertaking compensatory measures since teachers and pupils usually stay together even after regular school hours. Students have a considerable free time at their disposal to undertake developmental activities. Some of the activities that have been referred by the teachers are the organization of the picnic and taking students to outdoor activities. There is tremendous scope to channelise peer interaction making the children to undertake academic activities within the schools or out of the schools (Agarkar, et. al. 2002).

Bridging Policy and Practice

One of the major recommendations of the Education Commission Report (1966) was to teach science on compulsory basis up to the school leaving stage. Following these recommendations, curriculum guidelines were prepared and textbooks were written for primary, upper primary as well as for secondary level classes in the decade of 1970. The curriculum was basically discipline based where attempt was made to teach concepts in Physics, Chemistry and Biology. In order that the students can handle these disciplines at the secondary level, the upper primary syllabus was used as a preparatory stage The New Education Policy (1986), however, brought out the need for the teaching of science in an integrated fashion. Accordingly, new textbooks were developed highlighting the progress of science as a human endeavour for the pursuit of knowledge. As per the recent thinking (NCERT, 2000) science is to be coupled with technology as both of them usually go together. Efforts to bring out new set of textbooks based on this philosophy have been initiated by the National Council of Educational Research and Training (NCERT). Are the changes in policy transferred into practice? The study showed that many of the teachers do not have clear understanding of the aims and objectives of the changed science curriculum. In the absence of proper information, they continue to teach in their traditional way. Special efforts are required to ensure that policy gets implemented at the school level

There is a standard mode of evaluation that is followed in the Indian school system. It is based mainly on written mode of communication. Pupils who have not developed adequate skills in written communication are often at disadvantage and perform at lower level than they deserve. This aspect is found prominent in case of technical subjects like science that make profuse use of technical jargon. What is required is to adapt different methods of evaluation. One suggestion pertained to oral testing and activity-based testing. These methods are seldom used in the testing at the upper primary level Now is the time to review them to bring about improvement in the method of evaluation

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How Should Science Teachers be Assessed?

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Much is written and discussed pertaining to science teacher accountability. All people need to be accountable to achieve objectives in society. When this writer came to teach at Truman State University in 1962, then Northeast Missouri State Teacher's College, a consultant spoke to the Division of Education on being accountable, well ahead of the time when this concept became a household word to teachers and administrators. He mentioned that as a science teacher anyone could come into his classroom to observe and notice the quality of his teaching. Nothing was said there about documenting teaching quality. When thinking back about the consultant's ideas, there appeared to be much merit in what he was saying. First hand then, an observer could come into the classroom to evaluate, comment after the class visit, and assess teaching quality.

There needs to be a just way of assessing teaching performance. In the present time, there are many variables which hinder some kind of agreed upon objective and fair way of assessing science teacher's progress. By discussing the pros and cons of each procedure, perhaps, a synthesis may be reached. Different schools of thought in assessing teaching performance have unique inherent philosophies These need analysis in order to come up with a synthesis in moving from *what* is to *what should be*

The Measurement Movement

The measurement movement has been with educators since the beginning of the twentieth century. E L Thorndike (1874-1949) expressed selected basic measurement ideas such as the following in the early 1900s.

1 Whatever exists, exists in some amount

2. If it exists in some amount, it can be measured.

Thorndike and his associates were busy with developing diverse measurement instruments to ascertain numerically what students had learned and acquired in different subject matter areas (See Thorndike, (1918)). The steady growth in number of standardized tests resulted With standardization, each student in a class,

1 Took the same test.

2. Had the same time limits for taking that test

3 Was given the same directions for taking the test.

4. Had tests scored using the same answer key.

5. Had test results compared with the same norm group that the test was standardized on

Numerical results were and are provided to indicate how well a student did on the standardized test. Percentile ratings are generally provided. However, standard deviations above and below the mean, quartile deviations, stanine scores and grade equivalents also may be provided to reveal students' performance. With a numeral, such as a percentile, being given to indicate students' performance, quick methods are used to report students' achievement to parents and the lay public. Thus, a single numeral "tells it all."

Test results from students have been used to reveal the quality of teaching of a specific teacher However, there are many weaknesses here·

1. The playing field of students from school to school is anything but level. Students from suburbia have always achieved much higher on standardized tests as compared to urban and rural learners. They have had much better opportunities to learn in the preschool years as well as after school. Selected educators believe that standardized tests measure socio-economic levels rather than academic learnings.
2. Standardized tests have their many weaknesses. Thus, with standardized means of assessing, "one size fits all " And yet, students differ from each other in many ways, such as abilities possessed, quickness in responding to test items, motivation, and purpose in learning.
3. Standardized tests claim to measure objectively. However, there is little objectivity when science subject matter is selected to be in a test. Human beings make these subjective decisions. Certain included subject matter will be more familiar to selected students as compared to others due to the region the school is in. Selected units of study taught in a school or school system may appear, in part, on a standardized test. Other schools may have taught selected subject matter which is not appearing in the test. For all to have had equal opportunities to learn science subject matter contained in a test is impossible.
4. Weaknesses exist also in the many assumptions that standardized tests operate on. Thus, a question may arise on how valid a test is, even though the correlation figures presented in the manual is high To truly be valid, the learning activities in any school need to be aligned with the objectives of the test. And yet, standardized tests have no objectives for teachers to use the tests as benchmarks in teaching students in the classroom.
5. Standardized tests have been criticised for stressing reliability to the minimizing of validity concepts Thus, standardized tests in many cases do have a difficult time in relating test items thereon to what is being taught in the school setting. Students in the class setting will be tested with the use of standardized tests at selected intervals. Consistency of results in student testing is easier to obtain when using

test/retest, alternate forms, or split-half reliability, as compared to having demonstrated validity in a test.

It becomes difficult to make a case in holding teachers accountable for student results in science after the latter has taken the involved standardized test. (See Ediger, 1994, 169-174).

Teacher Assessment and Criterion Referenced Tests (CRTs)

To remedy a deficiency, CRTs were developed, usually under the auspices of state departments of education. CRTs do have accompanying science objectives for teachers to use as benchmarks for teaching students. Test items on the CRT tend to be more valid as compared to standardized tests in that they relate directly to the stated objectives used by the teacher in teaching. However, sometimes, the objectives are too open-ended, making it difficult for the test item to truly reflect and measure what is in the stated objective(s).

Companies developing and selling standardized tests have more money available than do state departments of education to do research on the quality of their tests. Generally, multiple choice test items are used on standardized tests and CRTs. Weak test items need to be taken out in pilot studies conducted. Thus with a printout of students' results in a pilot study, the evaluator of these tests may view the quality of each item by observing test item analysis therein. If all students, for example, were correct in responding to a test item, the chances are that test item lacks sophistication to notice students' achievement. Or, if all students responded incorrectly to a test item, the chances are that multiple choice item needs to be evaluated in terms of clarity in writing.

A further problem in using tests to measure students' achievement and determining related teachers' effectiveness in teaching science is to decide upon how high the standards should be for learner achievement. In an era when "high standards' for student achievement are being emphasised, a problem arises as to how high should the hurdle be. Test items can be written on a level whereby each taker of the test can be successful in responding. The converse may also be said in that a test can be written at a highly complex level in which all or most would be unsuccessful in test results from having taken the test. This writer has mentioned this frequently in his Methods of Research class by giving examples in class for graduate students to respond to, such as what is 1+1, 1+2, and 1+3, whereby all are correct 100% of the time, unless human error comes in Then, too, test items may be written at a very complex level so that all/nearly all would fail, especially if validity is lacking in testing. With multiple choice test items, there is a one in four chance of guessing correctly as to which is the correct answer. If one or two of the responses in a multiple choice test item are ridiculous, the correct answer is much like a true/false item in that either one or the other answer is correct.

With testing in a paper/pencil situation, realism and practicality in the situation is a problem. For example, individuals at the work place are not tested to show proficiency. Rather, they do the work required to demonstrate quality and productivity. Perhaps, in assessing achievement in the school setting, more opportunities should be provided to students, whereby they indicate in a practical situation what has been achieved. Thus, in units on Citizenship and Ethics, can the student truly show quality traits of character when interacting with others? Test results may not stress this interaction which is at the heart of citizenship and ethics education (See Ediger, 1995, Chapter Seven).

Multiple Intelligences Theory (See Gardner, 1993) indicates the need for students to be able to show what has been learned through diverse procedures, not paper/pencil tests only. These intelligences include scientific, verbal, kinesthetic, artistic, interpersonal, intrapersonal, musical and mathematical aspects. For example, a student may show what has been learned best through music when indicating learnings acquired from studying science. Many songs have been set forth in music that stress content in science. The point is that students should use the intelligence(s) possessed to show content and skills learned and not through paper/pencil testing only or largely. Gardner (2000) when asked in an interview why he criticised the facts-based, standardized test approach in k-12 education, responded with the following:

Facts are just bits and pieces of knowledge. They acquire meaning only when combined into significant patterns. Facts alone are like Christmas tree ornaments without a tree. Standardized tests that look at how many facts students know, as opposed to what they understand, force teachers to present these unconnected ideas. Then learning comes about choosing the correct answer on a multiple choice test. I think students should focus on a limited number of important topics, explore them in depth, and come to understand them well. Assessment ought to focus upon the kinds of things we want students to understand, and give kids a chance to perform their understanding.

Testing and measurement procedures to assess science teaching performance then have their limitations in criterion referenced testing as follows.

1 One test is to show learners' achievement even though given once a year at the most.
2. A single numeral here, such as a percentile, is to indicate students' achievement over time.
3 Isolated information provides the basis for testing with the use of multiple choice test items.
4. Little, if any, feedback from student test results is provided to teachers for diagnostic and remedial work.
5. A numeral is provided to parents to show their child's progress.
6. Report cards may be issued in a state to compare test results in contrasting one school or school system with another. The playing field here is not level at all in

comparing school achievement results involving suburbia, urban and rural school achievement. Suburban teachers definitely have an advantage since their students are bound to achieve significantly higher than those from urban and rural schools

7 CRTS, if not properly field tested, might have a large Standard Error of measurement (SE meas). A large number of weaknesses may then be inherent in the involved CRT. CRTs need to have high reliability with alternative forms, split half, and/or test-retest reliability.

8. Open-ended science objectives for teachers to use as benchmarks in teaching may not be precise enough to choose aligned learning activities. Validity then becomes weakened since the test items' on the CRT should relate directly to the stated objectives.

9. Fragmented learnings are generally measured in CRTs with its multiple choice test items.

10. Testing does not occur in context within an ongoing lesson or unit of study. The test items are prepared by those outside of the local classroom (See Ediger, 1995, ERIC # ED 386319)

Accountability has been a key concept with the use of CRTs to gauge teacher effectiveness in terms of how much students have learned based on test results. There are numerous weaknesses here based on the above enumerated items.

Portfolios and Teacher Accountability

Portfolio use stresses a philosophy of contextualism when appraising teacher effectiveness in the classroom. Contextualism stresses assessing within ongoing lessons and units of study in terms of student learning. The assessing is not done by outsiders, removed from the local classroom It does not deal with isolated bits of information that is observed on most standardized tests and CRTs It does not stress a numerical result unless rubrics are used However, even though the intent is to be objective, rubric ratings and their respective definitions tend to be quite open-ended and subject to human interpretation, Any product/process of a learner assessed in terms of rubric criteria, such as on a five-point scale, will face problems of interrater/interscorer reliability.

Portfolios and their contents need to be aligned with stated science objectives. Definite benchmarks for teaching and learning need to be in evidence Anarchy in teaching should not be inherent and must be avoided. To gauge students' science learning and teachers' effectiveness, what might go into a portfolio?

1. Written science reports, outlines, summaries, poems, stories, plays, and expository information.
2. Art products, as they relate to ongoing science lessons and units of study.
3. Snapshots of construction work, dioramas and friezes.

4. A video tape showing student participation in collaborative endeavours using a hands-on approach in science learning.
5. Self evaluation results from the involved student.
6. Classroom test scores based on specific units of study
7. Teachers' evaluation of the student' progress in science.
8. Diagrams and drawings illustrating ideas learned in subject matter.
9. Cassette recordings of oral presentations.
10. Computer printouts of completed work, related directly to the local curriculum.

A Portfolio should not be too voluminous since they should be assessed by at least two professionals. Nor should they be too slender and not provide appropriate scope pertaining to what a student has achieved. What are selected drawbacks pertaining to portfolio use to assess teacher effectiveness?

1. They will tend to lack validity, in the traditional sense of testing philosophy, since the portfolio is quite open-ended in terms of relating to the stated objectives. The objectives too will tend to be more open-ended as compared to measurable stated ends generally used for CRTs.
2 Reliability will not be as precise and specific as compared to CRTs and standardized tests. Why? Interrater and Interscorer reliability may vary considerably from one assessor to the next.
3. If the services of paid assessors are used, the cost of assessing may be quite great. Machine scoring of portfolios is presently impossible
4 Much subjectivity is involved in students' determining what is to go into a portfolio However, is it any more subjective as compared to test writers of standardized and CRTs ascertaining which context should be measured to indicate students' achievement?
5. Difficulties involved in parents and the lay public attaching meaning to voluminous portfolio contents to ascertain teachers' effectiveness A single numeral from a standardized test or CRT is much easier to comprehend due to its simplicity (See Ediger, 1997, Chapter Five).

Additional Comments

There are numerous additional approaches that have been used to assess teachers' accountability. Teachers' tests on the state level have been used to assess achievement in knowledge pertaining to teaching. If a teacher fails the state mandated test, he/she can lose credentials for teaching based on a single test's results. Generally, the test can be taken over by the teacher, if failure has occurred on the initial test taken. Usually, state mandated tests for teachers attempt to show the defectiveness of undergraduate preparation programmes for teaching. A single test is to reveal more than an entire undergraduate degree programme from an approved teacher education degree institution.

A second procedure emphasizes bankruptcy laws in education. Thus, if an entire school has students that do not measure up to a selected standard, the school or school system may be taken over by the state and new administrators appointed and in-service education for teachers becomes a top priority. The entire school is then held accountable, not an individual teacher.

Thirdly, workshops, faculty meetings, and clinical supervision have been used to upgrade science teaching skills. A major problem here pertains to who should determine which are the best procedures, to assist teachers to help students achieve as optimally as possible. For example, the philosophies of testing and measuring with standardized tests/CRTS are considerably different as compared to contextualism and portfolio use. Or, behaviourism with its measurably stated objectives, predetermined, is quite different from humanism with its student centered procedures of instruction.

Fourth, there are many issues involved in testing in and of itself, including a lack of agreement on the use of high stakes testing. Failing in a high stakes test may indeed be devastating to a student, such as not being able to graduate from high school. The involved tests used may not measure that accurately as selected educators may assume.

Fifth, the entire area of assessment is open for debate. Students are not like engines with standardized parts. They possess a feeling dimension, as human beings, which is definitely subjective. Each person has different feelings about happenings, events, goals in life, aims, and purposes. To standardize feelings violates a basic dimension of the human being and that is the subjective factor.

In closing, there are numerous articles written about what makes for effective schools. These need careful consideration. Cawalti (2000), former Executive Director of the Association for Supervision and Curriculum Development, lists the following benchmarks for quality schools:

1. A highly committed faculty.
2. Strong leadership from the principal.
3. Extensive time for reading.
4 Extending time spent on task.
5. Incentives and recognition.
6. A pre-assessment programme and students practicing on what will be tested on involving the state mandated test.

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Understanding Talent in Science Classroom: An Exploratory Study

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'I see the facilitation of learning as the aim of education, the way in which we develop the learning man, the way in which we can learn to live as individuals in the process.'

–Carl Rogers

Statistical definition of 'talent' is seen in terms of percentage of individuals who range above average on standardised Intelligence and Achievement tests, derived from the frequency curve of distribution of abilities like concept formation. According to this, a talented individual is one who deviates to a substantial degree in a plus direction from the average of his age group. Talent emerges from general ability as a confluence of genetic disposition, home and school experiences and students' interests and learning styles. Gagne (1985) delineated a general pattern of talent development in youth. Gardner (1993) defines talent as complex of aptitudes or intelligence, learned skills, knowledge and motivation, attitude, disposition that predispose an individual to success in an occupation, vocation, profession, art and business. Braggett (1994) defines talent as an outstanding or highest level of performance but the context for the development of talent begins in a family, extends to school and later on to increasing peer influences and then to the influences of the experts and the culture and finally to high-powered influence from the domain or discipline in which one is emerging. Gagne (1985) suggested that giftedness is most often associated with an intellectual ability, while talent denotes more specific skills and aptitudes. He concluded that general giftedness which manifests itself in major domains (intellectual, creative, socio-emotional and sensorimotor) gives way, as children move through the years, to specific talent mediated by family, school, personality, interests, attitudes and identification experiences. Talent emerges as specific ability that facilitates learning or development, occupation or domain of occupation. From an intensive study of the lives of talented people, Bloom (1988) concluded that talent potential is present in many children and its growth can be facilitated by family and teachers; early recognition and nurturance are vital and motivation is a crucial ingredient.

Development of talent enables an individual to achieve to her greater potential; prevents her from encountering the wasteful boredom of work that is not challenging; trains even the most facile student in the ethos of hard work; and advances the intellectual and aesthetic legacy of civilisation. The

Question then arises-what causes some people to use their intellectual, motivational and creative assets in such a way that it leads to outstanding manifestation while others fail to achieve high levels of accomplishments inspite of having equal amount of intellectual and creative power?

Renzulli (1992) in his famous 'Act of Ideal Learning' aptly argued about a dynamic interaction between and among the learner, the teacher and the curriculum. He emphasised that a better understanding of the sub-components and interaction would lead to more effective ways of development, not only of levels of competence but also within discipline thinking, the self understanding and the passion of scholarship

Talent in science is in great demand in today's world whether it is in the area of genome, information technology, nanotechnology or in medical sciences. Lack of proper facilities, encouragement and identification of special talent in science has made brain-drain a pervasive reality in our country How can we remain indifferent to the nurturance of talent in our science classroom? When our country is in dire need of native talent, how can we allow waste of talent particularly that in science? Besides, science is an area of intellectual activity in which children can display remarkable ability. Science is a search - a search for knowledge, for unity in diversity, for patterns in the events that seem to be unrelated To do science is to nurture the very creative existence of one's self.

The Study

The present study attempted to understand

- the attitude of the talented students in science towards their subject.
- attitudes of the teachers towards their talented students.
- self perceptions of the students.
- personality traits of the talented students in science.
- problems, if any, faced by the talented students in and outside the classroom

The major objective of the study hence, was to explore the interactive dynamics of science classes so as to understand the possible reasons for non-performance in science.

Method

In the formulative or exploratory study, premium is on the discovery of ideas and insight. Therefore the research design has the scope of being flexible. The present study followed a descriptive mode with an emphasis on correlations of different variables Analysis of data was done through both quantitative as well as qualitative approaches.

Sample

Two hundred and five students from Classes IX and XI of two reputed public schools were chosen as sample population out of which only fourteen were selected as 'Talented' in science on the basis of criterion tests developed by the authors. Students who got more than 80% on this criterion test (sample attached) were selected as 'Talented in science'.

The number of science teachers selected was ten. They belonged to the same schools and were well-known to the students.

Tools

Inventory-I — To understand an individual student's perception of self in relation to science.

Inventory-II — To explore the students' attitude towards science.

Inventory-III — To study the personality profiles of the talented students.

Inventory-IV — To understand the Teachers' attitude towards their students' talent.

Behaviour Checklist — to collect teachers' ratings of the behaviour of their talented students in varied situations.

Analysis of Data

Means, standard deviations and correlation coefficients were calculated with the proper correction needed for the small sample size.

Table 1 presents the raw data on all the measures applied. Table 2 maps the means and standard deviations on different measures. Tables 3, 4 and 8 are for coefficient of correlation and Tables 5, 6 and 7 give the comparative pictures of the different dimensions of the study.

TABLE 1

S. No.	Name	Class	School	*Marks obtained on*										IQ % ile	Class-room test%
				criterion test (%)	*I-1*	*I-2*	*I-3*	*I-4*			*I-5*				
								Tp	*Tc*	*Tb*	*Tp*	*Tc*	*Tb*		
1.	Abhijeet	XI	SVMS	86	34	38	36	55	59	-	30	31	-	95	75
2.	Sarita	XI	SVMS	84	32	34	35	57	62	66	16	30	34	92	72
3.	Vibhore	XI	SVMS	85	32	32	37	60	71	0	30	32	-	96	84
4	Shashank	XI	SVMS	84	32	31	33	63	66	-	29	32	-	90	87
5	Khuspreet	XI	MMS	83	33	30	35	68	56	68	34	33	39	91	80
6.	Gaurav Joshi	XI	MMS	86	24	28	34	62	49	61	31	30	25	89	84
7	Surabhi	XI	MMS	85	31	28	31	74	71	76	33	34	35	88	83
8.	Charu	XI	MMS	84	29	25	30	65	57	66	31	28	30	90	80
9	Kapil Pawaria	IX	SVMS	82	28	32	32	63	66	66	29	33	31	89	82
10	Pratul K Singh	IX	SVMS	81	30	29	31	62	74	72	31	31	34	92	84
11.	Mitesh	IX	SVMS	84	35	32	34	58	72	60	32	37	35	95	76
12	Vishal	IX	MMS	82	34	38	35	65	40	58	32	17	28	95	74
13.	Vinny Arora	IX	MMS	85	34	38	36	65	64	69	32	32	30	92	82
14.	Nimmy	IX	MMS	84	33	32	33	40	52	47	17	22	27	93	70

TABLE 2
Status of talented students in science on different variables

S.No	*Variable*		*Mean*	*Standard Deviation*
1	Criterion Test			
2.	Classroom Test		31.5	2.95
3.	Self Perception of Students (Inventory-I)			
4	Attitude of Students Towards Science (Inventory-II)		31.93	3.99
5.	Personality (Inventory-III)		33.71	2 13
6.	Behaviour Checklist for Teachers	Physics Teacher	61.21	7.74
		Chemistry Teacher	61.35	8 23
		Bio-Teacher	64.45	7.80
7.	Attitude of Teachers towards Talented students	Physics Teacher	29 07	5 51
		Chemistry Teacher	30 35	5.17
		Bio-Teacher	31 64	5.43

After a close scrutiny of the table, the important findings obtained are:

1 Students scored more or less same on the various tests/tools

2 Different subject teachers have different perception for talented students.

TABLE 3
Correlations between various attributes of students

S.No.	*Variable*	*Mean*	*Standard Deviation*	*Correlation*
1	Self perception of Students (Inventory-I)	31.5	8 73	r12=+0 63
2.	Attitude of Students to Science (Inventory-II)	31 93	15 92	
1.	Self Perception of students (Inventory-I)	31 5	8.73	r13=+0 506
2	Personality (Inventory-III)	33.71	4.52	
1.	Attitude of students to science (Inventory-II)	31 93	15 92	r32=+0 65
2	Personality (Inventory-III)	33.71	4.52	

The table reflects that there is a positive correlation between the self perception and personality of talented students in science and their attitude towards science. This means that one who is talented in science will have positive self perception and healthy personality.

TABLE 4
Correlation between students' self perception and teachers' attitude towards talented students

S No.	*Variable*	*Mean*	*Standard Deviation*	*Correlation*
1.	Student's self perception (Inventory-1)	31.5	8 73	-0.063
2.	Physics teachers' attitude to talented students (Inventory-V)	29.07	30.38	
1	Student's self perception (Inventory-1)	31.5	8 73	-0.082
2	Chemistry teachers' attitude to talented students (Inventory-V)	30.35	26.71	
1.	Student's self perception (Inventory 1)	31.5	8.73	+0.32
2.	Bio-teachers' attitude to talented students (Inventory-V)	31.64	24.55	

From the table, it can be inferred that there is a negative correlation between students' own self perception and their physics and chemistry teacher's perception about them. On other hand the perception of biology teachers and students' own self perception are positively correlated

TABLE 5

Comparison of talented students of the two schools with reference to their self-perception, attitude to science and personality.

S No.	*Variable*	*School*	*Number of subjects*	*Mean*	*S D*	*Obtained t-Value*	*Tabulated t-Value*	*Significance*
1.	Self perception of students (Inventory-I)	Shiv vani Model Sr Sec School Palam	7	31.86				No significant difference at 0.01
		Meera Model School Janakpuri	7	31.14	9.325	0.145	2.68	
2	Attitude towards science (Inventory-II)	Shiv vani Model Sr Sec School Palam	7	32.57				No significant difference at 0.01
		Meera Model School Janakpuri	7	31.28	2.26	0.57	2.68	
3	Personality (Inventory-III)	Shiv vani Model Sr. Sec. School Palam	7	34				No significant difference at 0.01
		Meera Model School Janakpuri	7	33.43	1.16	0.49	2.68	

The above table reflects that the talented students in science from both the schools do not differ with reference to their self perception towards science and personality

TABLE 6

Comparison of physics, chemistry and biology teachers with reference to their attitude towards talented students and behaviour of talented students

S.No	*Teachers*	*Number of subjects*	*Mean*	*S.D.*	*Obtained t-Value*	*Tabulated t-Value*	*Significance*
1.	Physics	14	90.28	5.038	0 28	2.08	No significant difference at 0.01
2.	Chemistry	14	91.71				
1.	Physics	14	90.63	5.038	1 03	2 53	No significant difference at 0.01
2.	Biology	14	96.1				
1.	Chemistry	14	90.00	5.67	1.07	2.53	No significant difference at 0.01
2.	Biology	14	96.1				

Table 6 reveals that the science teachers of the tatented students do not differ with reference to their attitude towards talented students and their behaviour

TABLE 7

Comparison of IX and XI grade students in relation to their self perception, attitude to science and personality

S. No	*Variable*	*Classes*	*Number of Subjects*	*Mean*	*S.D*	*Obtained t-value*	*Tabulated t-value*	*Significance*
1.	Self preception of students (Inventory-I)	XI	8	30.87	1.60	0.91	2.68	No Significant difference at 0.01
		XI	6	32.33				
2.	Attitude towards science (Inventory-II)	XI	8	30.75	2.09	1.31	2.68	No Significant difference at 0.01
		XI	6	33.5				
3.	Personality (Inventory-III)	XI	8	33.87	1.19	0.31	2.68	No Significant difference at 0.01
		XI	6	33.5				

Table 7 reveals that the self perception, attitude towards science and personality of the students talented in science do not vary with the age

TABLE 8

Correlation between the school academic performance and performance on criterion test of the students talented in science.

S No	*Variable*	*No. of Subjects*	*Mean*	*Correlation*
1	School's academic performance	14	79.5	- 0.16
2	Performance on criterion test	14	83.92	

The above table reveals that the school's academic achievement and achievement on the criterion tests prepared by the researchers are negatively correlated for the talented students

Summary of the Statistical Analysis

(a) The coefficient of correlation was positive between the scores on self perception in relation to science and that on personality inventory.

(b) The coefficient of correlation reflected a negative correlation between the talented students' self perception and the attitude towards talented students of physics and chemistry teachers but that between the biology teachers and talented students was low but positive.

(c) Schools were compared on different means and it was found out that there existed no significant difference between the means of any two variables.

(d) Teachers' attitude towards talented students when compared gave no significant difference. They did not differ in their attitude towards the talent of their students as well as on the behaviour checklist.

(e) The coefficient of correlation between the scores on criterion test and school test was negatively correlated.

(f) Analysis of Personality Inventory: Obedience stood out as the most preferred personality trait followed by aspiration, independence and helpfulness (Table 9). Though these talented students wanted to be independent and assertive, they also opted for obedience. Dominance, sincerity and self-confidence lagged behind the other positive traits. .

Analysis of Inventory III (Personality)

The researchers grouped the items of personality inventory into various categories and performed their qualitative analysis. Table 9 list the most occurring traits of students talented in science in terms of the responses given.

TABLE 9

S.No.	*Traits*	*Response (in %)*
1	Sincerity	75
2	Dominance	75
3	Assertiveness	80
4.	Cooperativeness	80
5.	Helpfulness	82
6	Compassion	78.5
7.	Self-confidence	76.1
8	Obedience	85
9.	Independence	82
10	Aspiration	84.5

From the above table it can be inferred that most of the talented students possess similar personality traits like Sincerity, Dominance, Assertiveness, Cooperativity, Helpfulness, Independence etc.

Major Findings

1. The Identified talented students in science possessed positive attitude towards science They wanted to participate in classroom discussion and enjoyed science as a subject.
2. As far as success was concerned, the talented students could set their own standard.
3. Teachers concerned failed to identify the talent of their students Therefore, talent in science never got identified/encouraged or nurtured in a science classroom.
4. Talented students identified on the basis of Criterion Test got comparatively less marks on the teacher-made tests.
5. Most of the talented students in schools seemed to be self-confident and mature. They expressed focussed aspirations and were aware of their potentials and limitations.
6. Although these students reflected a very favorable attitude towards science, most of them did not want to become scientists.
7. Almost all the talented students felt that their schools failed to do much to nurture their talent in science.
8. These students loved to participate in quiz and science fair as they felt challenged by such events.
9. They did not carry any gender bias so far as the science teachers were concerned.
10. The talented did not have many close friends. They also did not like to share their personal feelings with everybody.

Conclusion

Talent in science hardly gets recognised in our classrooms

Discrepancy in the scores obtained by the talented in the Criterion Test and teacher-made test reflects a lack of proper understanding of assessment procedure by the science teachers.

Though the talented students expressed their willingness to participate in science fair, science quiz, they hardly got chances to participate in such events. One of the reasons could be too much orientation of the schools on final results and not on learning or on joys of learning. Schools need to inform students about various prestigious competitions like National Science Talent Search, Olympiads so that the students can participate and enjoy their love for science.

Most expressed unhappiness with the quality of instruction of science teaching as traditional methods hardly challenge their intellectual curiosity.

Teachers need to be acquainted with the modern techniques of teaching particularly with the use of multimedia in their teaching. They should also update their knowledge and skills by attending workshops, seminars and orientation programmes arranged by SCERT, NCERT, Department of Education.

Unlike the popular belief that cognitively mature students are emotionally mature too, the identified talented students expressed their emotional needs which were not given proper attention. Parents should be made aware of the needs and importance of communication with their children. They should be counselled about the positive aspects of having democratic atmosphere at home. The talented students should be allowed to pursue their interests and the parents should have confidence in them.

Apart from emotional needs, a lack of intimacy with peer group was reflected in their responses also. Only very few of these talented students had close friends These children need counselling for a balanced development of their personality. Asynchronous development might create problems for them during their adulthood

Suggestions for Understanding and Nurturing the Talent in Science

The present study, though limited in its scope, brings about certain relevant issues which should be addressed by all who are interested in Science-Education.

The authors, through their interaction with the students and observation of the science classrooms encountered the following questions:

(a) Why were only some students and not all able to perform well on Criterion Test? Only fourteen students were selected as talented out of two hundred and five students

(b) Why did only about two/three students out of fifty students in a class participate actively in classroom discussion?

(c) Did the talented identified in the study possess some special traits which others did not have?

(d) If so, was it possible to inculcate and develop such traits among other students of science?

As the talented in science reflected a very positive attitude towards the subject and self, the authors suggested the following for inculcating a positive attitude towards science, self and others among all the students so that they could realize their potential in their chosen areas of specialization:

(i) Syllabus should be modified/adapted time to time depending on the ability levels of the students.

(ii) Students should be encouraged through guided independent study and experimentation.

(iii) Independent or self-directed/self-regulated study skills should be developed.

(iv) Teachers should work as facilitators/mentors and not as 'the authority' on the subject.

(v) The whole process of science education needs to be modified and reorganised.

(vi) Schools should arrange for science excursion, lectures by experts, visits to the science laboratories for inculcating positive attitude towards science.

(vii) Schools need to encourage counselling service in the school for both the teachers and the students so that they understand themselves, their problems and can handle these problems legitimately with the help of the counsellors.

Last but not the least, parents should be taken into confidence and counselled if needed for not mounting pressure on their children only for academic achievement. Children need to develop as balanced individuals cognitively, effectively and socially. A concerted effort by both parents and teachers can help a child discover her/his own talent and realize it to the fullest.

Criterion Test
Class IX

Note: All questions carry 2 marks each.

Q.1. It is dangerous to get down from a moving bus, Why?

Q.2 Why lysosomes are called suicidal bags?

Q 3. We know that the earth pulls a falling stone towards its centre. Why do we not see the earth moving upwards towards stone?

Q 4. Classify the following as elements, compounds and mixture:

Marble, Air, Gold, Sand, Diamond, Petroleum and Chalk.

Q.5. Which of the following pairs are isotopes and why?

1. ${}_{26}A^{55}$ and ${}_{28}B^{58}$
2. ${}_{35}X^{79}$ and ${}_{35}Y^{80}$

Q.6. How cutting of trees in Himalayan hills can disturb the water balance in areas far away in the plains? Explain.

Q.7. The distribution of electrons, protons and neutrons in the elements A to E is as follows.

Elements	Elections	Protons	Neutrons
A	4	3	4
B	8	9	9
C	18	18	22
D	17	17	2
E	17	17	18

Making use of this data, find

1 A cation
2. An anion
3. A pair of isotopes
4. An atom of Nobel gas.

Q 8. Meiosis II cell revision is similar to mitosis cell division. Why?

Q.9 An element 'A' forms an oxide A_2O_5

1. What is the valency of A?
2 What will be the formula of chloride of A?

Q.10 Explain how plants and animals utilize and dispose off the toxic ammonia formed as a result of breakdown of nitrogenous compounds?

Q.11. What type of reactions are represented by the following equations?

1 $A+BC \longrightarrow AC+B$
2 $A+B \longrightarrow C$
3. $A \longrightarrow B+C$
4 $A+B^{2+} \longrightarrow A^{2+}$

Q.12. The manipulation of environment by man have affected the habitat of other species Comment.

Q.13. Chlorine (atomic no 17) and Potassium (atomic no. 19) differ by one element and have +1 and — 1 valency but Sodium (atomic no 11) and Aluminum (atomic no. 13) also differ by one element and have valences +1 and +3 respectively. Explain.

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Assessment of Science Practical Skills of Students at Secondary Level

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A Science practical task drawn from secondary curriculum was administered to 33 students (20 boys and 13 girls) of Class X to assess their performance in the skills of following instruction, reporting and drawing conclusion The results showed that the students had developed an appreciable mastery in these skills. No significant differences were detected in the performance of boys and girls.

Introduction

Practical work has long been envisaged as an important means of providing learning opportunities in science. Main benefits of practical activities are: (i) reinforcement of the understanding of scientific concepts and principles, (ii) acquisition of practical skills and (iii) exposure of the students to the ways of working like a scientist (Lynch, 1986). However, most of the teachers especially in developing countries consider practical activities just to confirm Scientific knowledge (Monk et al , 1993). Only little attention is given to development of practical skills in students and their assessment while it has been opined by Lewis (1993) that for the measurable benefits of the practical work, it is essential that the achievement tests of science practical should assess the practical skills of students developed during practical work. Keeping in view the importance of practical skills in science and knowing that their assessment can act as feedback for the teachers to pay more attention on particular skills which the students lack, the present work was undertaken.

Objectives of the Study

1. To find out the level of performance of the students in the skills of following instructions for doing practical work, reporting and drawing conclusions in practical work related to secondary science curriculum.
2. To find out the differences in the performance of boys and girls in the aforesaid skills.

Methodology

The performance of the students in different skills was assessed by assigning them a practical task drawn from the curriculum of secondary science practicals The task was'

1. To identify the given samples (four) of water as hard and soft water.

   The instructions for performing the experiment had already been given in the class by the teacher. The students had to perform the experiment on the line of instructions given for the use of apparatus and materials; taking observations, reporting the observations and drawing conclusions.

To find out the levels of performance of students in different skills, a proforma was developed that was similar in some respects to that used in IEA second International Science Study (Kay et al , 1992). The proforma contained the following questions:

1 Outline the steps which you followed for performing the experiment.
2. Report your observations in a suitable format.
3. Draw conclusions for all the four sample giving reasons.

The scoring scheme developed by the author is given below:

1. Skill in following instructions for doing the experiments—
   (a) about apparatus and materials to be used 2 marks
   (b) about taking observations 2 marks
   4 marks
2. Skill in reporting —
   (a) Present the observations in suitable format 2 marks
   (b) Use of scientific language 2 marks
   4 marks
3. Skill in drawing conclusions —
   (a) giving reasons 2 marks
   (b) result 2 marks
   4 marks

In order to minimize the inter-rater variability, the whole marking task was done by the auther only The sample consisted of 33 students (20 boys and 13 girls) of Class X of a Central School situated in Bhopal (M.P)

Results and Discussion

Table 1 presents the results for the practical test in different skills It shows that the average score in each skill is more than 75 per cent. This implies that in the skills of following instructions, reporting and drawing conclusions, students have achieved high level of mastery. The main factors, contributing

TABLE 1
Results of the Practical Test

Number of students = 33

	Skill	*Mean*	*Standard deviation*	*Maximum Possible score*	*Per centage Score*
1.	Following instructions for practical	3.45	2.25	4	86.25
2.	Reporting of Observations	3.10	1.36	4	77.50
3	Drawing conclusion	3.52	1.15	4	88.00

to such a high performance seem to be:

(i) the learning environment in most of the central schools is very good;

(ii) highly qualified teachers are appointed in such schools;

(iii) the task given to the students was comparatively simple

Table 2 shows the achievements of boys and girls in relation to these skills. It is seen that in the skills of following instructions and reporting the observations, average scores of girls are higher than boys while in the skill of drawing conclusions the average score of boys is higher than the girls though in no case the difference is statistically significant at 0.01 level. In the present studies, findings in case of skill of following instruction for doing practical work show the same trend as in case of scottish data (Robertson, 1987) but in the latter case the performance of girls was significantly superior to boys. In case of skill of reporting Roger Lock (1992) had found no gender related differences which is in consonance with the present finding. Literature survey indicates that no gender based study has been undertaken for measuring performance in the skill of drawing conclusion in science practicals. However, since this skill has some conceptual overlapping with the skill of interpretation, comparison of the present results can roughly be made with the work related to interpretation skill. Gender-based studies on the interpretation skills suggest that some differences exist between the performance of boys and girls (Johnson and Murphy, 1986; Lock, 1992). Boys perform superior to girls. The results of this work show similar trend, though superiority does not acquire significant difference.

Implication of the Study

The study clearly indicates that the practical task included in the syllabus of Class X leads to develop the skills of following instructions, reporting and drawing conclusions.

No assumption should be drawn about the difference in the abilities of boys and girls. Both the sexes should be encouraged on equal footing for developing these skills.

TABLE 2

Performance of Boys and Girls in Different Skills

Skills	*Boys (N=20)*		*Girls (N=13)*		*t value*
	Mean	*Standard deviation*	*Mean*	*Standard deviation*	
1. Following instructions for practical	3.40	2.25	3.52	1.72	.165
2. Reporting of observations	3.06	1.52	3.15	1.36	.176
3. Drawing conclusion	3.58	1.94	3.42	1.15	.296

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Hypothesis Making Ability of the Biology Teachers

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Biological knowledge has long been considered as a well-defined discipline by the scientific community. Creation of new biological concepts, result due to its modes of inquiry. These modes of inquiry vary from problem to problem. However, processes like making and testing of a hypothesis form a common core of majority of the experimental studies conducted in biology discipline. Carl Rogers considers formation of a hypothesis as an act of true creativity. Creativity experts, therefore, favour development and nurture of hypothesis making among science students. Classroom transactions of hypothesis making and its testing depends on the teacher's ability and attitudes to develop/nurture this ability in their students. The main objective of this exploratory study had been to ascertain post-graduate biology teacher's ability to form hypotheses in their content area It seems important, in case, they manifest deficiency in coining hypotheses, then, they require orientation in framing and testing of hypotheses, so that they are able to develop/nurture this ability in their students.

Sample

Twenty postgraduate biology teachers formed the sample of this study. They came from Kendriya Vidyalayas and had teaching experience of five to eight years in Classes X through XII in biology. They were undergoing Biology orientation programme at Regional Institute of Education, Bhopal (June 2001).

Data Collection

The following task was employed in collecting data for making of hypotheses by the sampled teachers.

Grasshoppers attract their mates by using sound signals. Peacocks attract their mates by using colours Suggest three possible reasons why grasshoppers use sound rather than colour

Results

Responses generated by the sampled teachers were categorized into the following five groups:

(a) *No response:* Two Ss (10%) did not respond to the administered task. Probably these teachers were best convergent thinkers. Therefore, they opted out in attempting a divergent thinking task like this one

(b) *Information repeated:* Thirty percent of the Ss simply said that grasshoppers use sound in mating. Another 25 per-cent of them wrote that they are green in colour. These statements were not at all elaborated. Hence, a hypothesis cannot be deduced from them. They merely repeated given information only. It is quite unusual that 55 percent of these teachers failed to construct a hypothesis as to why grasshoppers use sound system in attracting their mates

(c) *Intuitive hypotheses*: The chief characteristic of this category of hypotheses banks on intuitive constructions that have not much direct relevance either with the sound and/or with the colour variable The following are the examples created under this head:

- Grasshoppers cannot dance like peacocks
- They do not have smelling power like cockroaches
- Their size is small
- They do not have well-developed optic lobes
- It forms a sex-psychological character
- Sound of peacocks is sweeter
- Pecten is found in the eyes of the peacocks.

Each of the hypothesis was made by 5 percent of the sampled postgraduate biology teachers

(d) *Less plausible hypotheses*: These hypotheses formation are related to other than direct sound and/or colour variables (5 percent each)·

- Well-developed wings in grasshoppers
- Grasshoppers fly for mating
- They produce transonic waves
- Nervous system is differently developed in grasshoppers
- They produce pheromones

(e) *Plausible hypotheses*: They bank directly either on colour and/or on sound variable.

COLOUR

- No discrimination of colour by the grasshoppers (10%)
- Mate cannot be sighted by the colour (5%)
- Colour camouflages among trees (15%)
- Dull coloured (5%)
- No coloured skin (10%)

SOUND

- Sound can be heard at a distance (5%)
- Sound system better developed (10%)
- Sound stimulates mating (5%)
- Male makes sound and female receives sound (10%)

Discussion

The sampled postgraduate teachers had been teaching biology subject to Classes X through XII for five to eight years. Maximum percentage of plausible hypotheses created by them ranged from 5 to 15 only. It simply means that out of 20 Ss, only one to three of them succeeded in coining a plausible hypothesis. A large number of them, i e., 85 percent failed to make a reasonably acceptable hypothesis as to why grasshoppers employ sound signals in mating instead of colour as used by the peacocks

During discussion, it was revealed by the teachers that their chief concern had been in transmitting prescribed textbook concepts in the classrooms. This transactional tactic ensured getting better marks by the students Therefore, it appears, they failed to appreciate formation of hypotheses related to a biological problem solving It is further evidenced by the fact that these teachers did not take interest in understanding the role of processes of science in investigatory projects Majority of them wanted a cook-book type of material for doing biology projects by their students. On another task that measured isolation and control of variables related to an inquiry problem, only 5 to 15 percent of them could correctly employ this process of sciencing.

All this seems unfortunate, for sciencing does not mean creation of a catalogue of factual information only. Rather, its chief aim being building of necessary scientific temper in students. It is needed by them in solving their daily life problems much more appropriately. This frame of mind does not develop by listening to the achievements of science. Students need appropriate interactions with the scientific realities (Objects, phenomena, etc.), to collect data, and, then data processing for the development of meaningful understanding Sciencing by the students, therefore, should form the core for the development of scientific temper in them Students manifest different levels of cognitive development They also develop processes of science gradually and slowly. Mastering of processes of science should follow the developmental characteristics of the students. On this premise, then, the following sequencing of science experiences has been suggested.

In the primary classes (I to V), sciencing by the children be rather exploratory in nature By the time children come to middle Classes (VI to VIII), one variable cause-and-effect relationship that banks on observation-inference processes be emphasised. In the secondary and senior secondary classes, experiments that hinge on isolation and control of variables be introduced. Role of a control group needs special consideration at this stage of science learning by the adolescents. Coining of a hypothesis and its experimental testing deserves attention investigating scientific realities. This mode of sciencing by the students requires re-structuring of the in-service programmes in process-based instruction A very high degree of deficiency (85%) shown by the sampled postgraduate biology teachers in hypothesizing ability supports their training in processes of science. Re-tuning them on already learnt biology course-contents would not help them in developing/nurturing processes of science in their students

Notes

Exploration is a spontaneous and unorganized activity that is related to silent aspects of the environmental objects/events, etc. Primary school teachers, therefore, should help children in exploring their immediate environment in the form of confirmation of their created predictions on the basis of observation-data collection-inference processes. In case, learning has been accepted as an active process, then, formation and testing of a hypothesis experimentally by the students as an essential element of sciencing cannot be easily dismissed.

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2002 Fields Medal and Nevanlinna Prize

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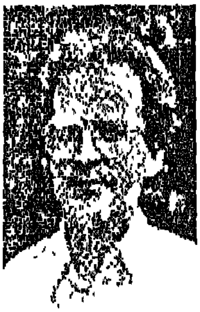
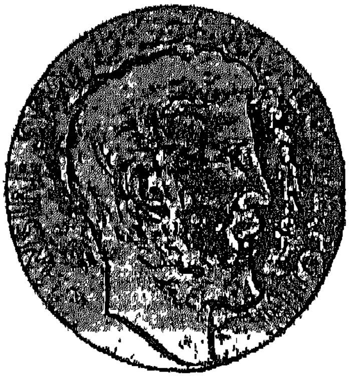
2002 Fields medal and Nevanlinna Prize in mathematics were awarded on Tuesday, August 20, 2002 at the opening ceremony of 24th International Congress of Mathematicians (ICM) held in Beijing, China from August 20-28, 2002. Two mathematicians, France's Laurent Lafforgue and Vladimir Voevodsky from Russia are winners of 2002 Fields medal prize

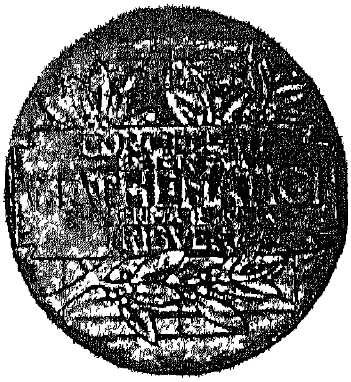


Laurent Lafforgue, born on Nov. 6, 1966 in Antony France, graduated from the Ecole Normale Superieure in Paris in 1986. He received his doctorate in 1994 and was made a permanent professor of mathematics at the Institut des Hautes Etudes Scientifiques in Bures-sur-Yvette, France in 2002. He was honoured for outstanding contributions in the "Langlands program" that sketches out new connections between number theory and analysis. His work is said to be "characterized by formidable technical power, deep insight and a tenacious, systematic approach".

Vladimir Voevodsky, born on June 4, 1966 in Russia graduated from Moscow State University in 1989. He received his doctoral degree in mathematics from Harvard University in 1992. He is working as a professor in the School of Mathematics at the Institute for Advanced Study in Princeton, New Jersey. He was honoured for developing "new cohomology theories for algebraic varieties". His work is "characterised by an ability to handle highly abstract ideas with ease and flexibility and to deploy those ideas in solving concrete mathematical problems".

Fields Medal is the popular / unofficial name given to the "International Medal for Outstanding Discoveries in Mathematics" and is often described as "the Nobel Prize for mathematics". It is regarded internationally as the most prestigious prize in the field of mathematics. The medal is awarded to mathematicians under the age of 40 at ICM held after every four years. Last one was held in Berlin from August 18-27, 1998. The medal is made of gold and shows the portrait of the Greek mathematician, Archimedes, and Latin inscriptions. The medal along with prize money of 15000 Canadian dollars recognizes the "existing work of mathematicians and the promise of future achievements". The design of the medal is described by Eberhard Knobloch as follows·





The word ΑΡΧΙΜΗΔΟΥΣ in Greek capitals mean "of Archimedes" that is face of Archimedes

RTM MCMXXIII means R(obert) T(ait) M(cKenzie), which is name of the Canadian sculptor who designed the medal in 1933

TRANSIRE SUUM PECTUS MUNDOQUE POTIRI

Which means "To transcend one's spirit and to take hold of (to master) the world".

On the reverse the medal reads,

CONGREGATI
EX TOTO ORBE
MATHEMATICI
OB SCRIPTA INSIGNIA
TRIBURER

"The mathematicians having congregated from the whole world awarded (this medal) because of outstanding writings" In the background there is a representation of Archimedes' sphere being inscribed in a cylinder.

John Charles Field, a Canadian mathematician, was the organiser of the International Congress of Mathematicians in 1924 in Toronto. In this congress, a resolution was adopted that at each ICM, two gold medals should be awarded to recognise outstanding mathematical achievements Prof. J C. Field proposed the institution of the award with the balance funds of the 1924 Congress. His proposal was adopted at Zurich ICM in 1932. The first medal was awarded in 1936 to Lars V. Ahlfors (Harvard University) and Jesse Douglas (MIT) at the World Congress in Oslo. In 1966 ICM, the number was increased and agreed to award upto four medals at each congress due to the great expansion of mathematical research. Since then two-four medals are awarded at each ICM. This highest scientific award for mathematicians plays the role of Noble Prize in mathematics.

Madhu Sudan was awarded Nevanlinna Prize. Madhu Sudan was born on September 12, 1966 in Chennai. He received bachelor's degree in computer science from IIT Delhi in 1987 In 1992, he received Doctoral degree in computer science from University of California at Berkeley At present he is working as associate professor in the Department of Electrical Engineering at MIT. Madhu Sudan is the first Indian to receive this highest scientific award He was honoured for his work on "probabilistically checkable proofs, to non-approximability of optimisation problems, and to error-correcting codes" His work is said to be "characterized by brilliant insights and wide-ranging interests"

International Mathematical Union (IMU) established the Rolf Nevanlinna Prize in April 1981 The prize consists of gold medal and a cash prize similar to Field's medal. The prize recognizes the work in mathematical aspect of information science. Like Fields medal, this prize is also awarded at each ICM. University of Helsinki finance the prize and thus has been named the Rolf Nevanlinna Prize in honour of Prof. Rolf Nevanlinna Reactor of the university of Helsinki and President of the IMU. Besides this, he had taken initiative to the computer organisation at Finnish Universities in 1950s.

Our students in schools do not know about this highest award conferred on mathematicians. Infact, this question was asked to a number of 8th and 11th class students in six schools situated in South Delhi. Not a single student knew the answer. Teachers should initiate such discussion in the classroom to create general awareness among students

Science News

Thousands of Cold Anti-Atoms Produced at CERN

Another milestone in the field of particle physics was accomplished in September, 2002 when an international production of antihydrogen atoms at low energies became possible for the first time at CERN.

An international team of physicists working at the Antiproton Decelerator (AD) facility at the European Organisation for Nuclear Research, CERN has announced the first controlled production of large numbers of antihydrogen atoms at low energies. After mixing cold clouds of trapped positrons and antiprotons - the antiparticles of the familiar electron and proton - under closely monitored conditions. The Antihydrogen Production and Precision Experiments (ATHENA), carried in collaboration with a number of International and National Research institutes spread throughout the world, has identified antihydrogen atoms, formed when positrons bind together with antiprotons The results are published in 'Nature'

Professor Luciano Malani, Director General of CERN, announced in the third week of September, 2002 that the controlled production of antihydrogen observed in ATHENA is a great technological and scientific event. Even more so because ATHENA has produced antihydrogen in unexpectedly abundant quantities. I would also like to recognize the contribution of the ATRAP experiment at CERN, which has pioneered the technology of trapping cold antiprotons and positrons, an essential step towards the present discovery

The ATHENA experiment, which is run by a collaboration of 39 scientists from 9 different institutions worldwide, saw its first clear signals for antihydrogen in August, 2002 – appropriately, the 100th anniversary of the birth of theorist Paul Dirac who predicted the existence of anti-matter in the late 1920s. According to Rolf Landua, ATHENA spokesman, the experiment is a major milestone in anti-matter science and an important first step on the road to high precision comparisons of hydrogen and antihydrogen. Such measurements will provide information vital to our understanding of the Universe and in particular, why nature has a preference for matter over anti-matter

The method which ATHENA uses overcomes the two main limitations of previous experiments both at CERN and at Fermilab in the US, which produced only a few anti-atoms per day with velocities close to the speed of light. First, the Antiproton Decelerator (AD) takes high energy antiprotons and slows them down to the leisurely pace - by CERN's standards - of a tenth of the speed of light. ATHENA then traps the antiprotons in a "cage" created by electromagnetic fields, and reduces their velocity further to a few millionths of the speed of light The ATHENA apparatus captures and slows down—or "cools"- about 10,000 antiprotons from each bunch that arrives from the AD. The next stage is to mix them with about 75 million cold positrons. These are collected from the decay of a radioactive isotope, then caught within a second trap, and finally transferred to a third, "mixing" trap. It is here that cold, that is, very slow, antihydrogen atoms may form

Central to ATHENA's observations is the antihydrogen annihilation detector, which surrounds the trap where the antiprotons and positrons are mixed. When a positron and an antiproton bind together to form a neutral antihydrogen atom, it escapes the trapping electromagnetic fields, which are set up by metal electrodes The anti-atom then strikes one of the electrodes, and the positron and antiproton annihilate separately, with an electron and a proton, respectively, in the surface of the metal

The detector provides unambiguous evidence for antihydrogen by detecting the simultaneous annihilations of the antiproton and the positron, which occur at the same time and at the same position. ATHENA finds that several anti-atoms per second are produced on average during the procedure that mixes the positrons and antiprotons. So far the experiment has produced about 50,000 antihydrogen atoms.

ATHENA is one of two experiments set up to search for cold antihydrogen at the AD Last year the Cold Antihydrogen for Precise Laser Spectroscopy (ATRAP) experiment was the first to use cold positrons to cool antiprotons. The experiment also successfully confined both ingredients of cold antihydrogen in the same trap structure. This simultaneous trapping of positrons and antiprotons was first demonstrated by TRAP, the predecessor to ATRAP, which operated on the Low Energy Antiproton Ring (LEAR) at CERN.

These breakthroughs at CERN are important milestones on the way to trapping, accumulating and cooling antihydrogen. Cold antihydrogen will be a new tool for precision studies in a broad range of science. Most fundamental will be the comparison of the interaction of hydrogen and antihydrogen with electromagnetic and gravitational fields. Any difference between matter and antimatter, however small, would have profound consequences for our fundamental understanding of Nature and the Universe.

CERN is the European Organization for Nuclear Research, the world's largest particle physics centre. Founded in 1954, the laboratory was one of Europe's first joint ventures, and has become a shining example of international collaboration From the original 12 signatories of the CERN convention, membership has grown to the present 20 Member States.

Over the past 20 years, scientists at CERN have been using antiparticles in many different ways for their daily work. Antiparticles can be generated by colliding subatomic particles. Before being delivered to the various physics experiments, they must be isolated, collected and stored in order to tune their energy to the appropriate level.

Until now, a dedicated machine with the main purpose of providing high-energy antiparticles has carried each of these steps. But now the first "self-contained antiproton factory", the Antiproton Decelerator (or AD), is operational at CERN. It will produce the low energy antiprotons needed for a range of studies, including the synthesis of antihydrogen atoms-the creation of anti-matter.

(Source: CERN Press Release)

New Method for Elusive Math Problem

A three-member team of scientists at the Indian Institute of Technology (IIT), Kanpur have devised a method that will make no mistake in quickly determining a prime number — those that are divisible only by themselves and 1. Indian computer scientists, thus, have solved a mathematical problem that has eluded researchers for 2,200 years — and could be crucial in modern times in improving computer configurations. Greek mathematician Eratosthenes was the first to raise this problem around 200 B.C., when he offered one way of determining whether a number is prime.

Prime numbers hold the key to solve many mathematical problems and play an important role in cryptography. Scientists have long worked on ways to improve methods to identify a prime number Computer scientists and mathematicians have since devised many faster ways to solve the problem, but all such methods carry a small risk of error. Some methods occasionally fail to detect a prime number, while others may select a non-prime number.

According to Manindra Agrawal, the Principal-author of the formula, their algorithm is deterministic; it has no chance of committing any error. An algorithm, it may be recalled, is a set of instructions for solving a specific mathematical problem in a limited number of steps Agrawal and his two associates — Neeraj Katyal and Nitin Saxena — have written a paper detailing the formula; copies of the paper were dispatched to leading computer scientists and mathematicians across the world besides being posted on one of the websites of IIT, Kanpur inviting comments on the paper.

Agrawal and his associates received several responses. All of them have expressed satisfaction with the new algorithm. No one has doubted the claim made by the team. However, the new algorithm will have no immediate applications because current methods used in computers are faster

Agrawal explains that they have used more steps than the current methods in use. The first objective was to find a method that is foolproof. In his opinion, it will not be long before other researchers, or may be some of us, will start asking how can the number of steps be cut down and make the computation faster.

Virus Built from Scratch

A group of U.S. researchers have claimed that they had built a poliovirus from scratch using only a genetic map as a guide. They have used it to infect and paralyze mice in laboratory. According to researchers, it is the closest anyone has yet come to creating life in a test tube— although scientists deny a virus, which is not a living cell but which can replicate itself, is alive in the same way as a bacterium, a plant, or a human being is. The report of the study researchers at the State University of

New York in Stony Brook makes a mention that if the ability to replicate is one of life's attributes, then poliovirus is a chemical with a lifecycle Nonetheless, it has genetic material like all other life.

However, Eckard Wimmer, who led the study, denies that he has created life According to him, his group has created a chemical in a test tube that, when put into cells, begins to behave a little bit like something alive Some people consider viruses to be chemicals and Wimmer belongs to that group Wimmer explained that once the right genetic parts were in place, the virus virtually self-assembled in a lab dish.

Poliovirus does not have DNA like many organisms, but starts out with RNA, which is the working version of DNA DNA carries the genetic code in cells, and is transcribed into RNA, which controls the production of individual proteins.

To make a virus, Wimmer and colleagues Jeronimo Cello and Aniko Paul had to first take a step backward Since RNA cannot be synthesized, the researchers converted the sequence from RNA into DNA that can be synthesized. To go back to RNA, an enzyme which can read DNA and synthesize RNA was used. That RNA was then put into a cell-free juice that researchers have developed in 1991 ... and lo and behold, out came the virus! It built itself. Taking the virus's favourite home —a human cell—shredding it up and removing the big pieces such as the nucleus make the "cell-free juice".

There were not too many ingredients to throw into the broth. Poliovirus has a single, long gene that produces what is called a polyprotein. But the virus can cut this long protein into smaller pieces that can be used for its few functions The virus acted like polio in the test tube and also paralyzed mice genetically engineered to be susceptible to polio, which in nature prefers to infect human beings. Polio once paralyzed tens of thousands of children a year, before vaccination made it a rare disease According to Wimmer, the process did cause some mutation in the genetic code, which seemed to weaken the effects of the virus

There are good vaccines for polio, but Wimmer hopes his team's process might be used to create genetically weakened versions of other viruses for use as vaccines His team is also working with the hepatitis C virus.

New Cold Treatment Developed at the University of Virginia

Scientists at the University of Virginia, USA have developed a new combination drug therapy that knocks out common colds. According to results of the study, the control group subjects were asked to use a new combination of drugs that stopped their viral infection and reduced symptoms by as much as 73 percent with no serious side effects.

According to Dr Jack M. Gwaltney, Jr , Chairman, Division of Epidemiology and Virology in the Department of Internal Medicine at University of Virginia and principal investigator of the study, the new treatment is based on delivering a double blow to the cold illness. One part of the treatment knocks out the virus which causes the infection, and the second part blocks the body's response to the infection, which is the cause of cold symptoms.

Gwaltney, Dr J. Owen Hendley and Dr Birgit Winther, who are co-investigators of the study, have pioneered research on what causes cold symptoms at University of Virginia. Their findings over the last two decades challenge the belief that cold symptoms are the result of the damage that a cold virus does to the lining of the nose. Instead, the researchers have found that virus damage to the nasal lining is minimal, and the symptoms of a cold are due to the body's inflammatory response to the infection. In recent years, this group and other investigators have identified a number of inflammatory pathways associated with cold symptoms:

- Stuffy nose results from dilation of blood vessels in certain tissues in the nose called 'turbinates'. When the blood vessels dilate, turbinates swell and block air passages, making breathing through the nose difficult. Certain natural inflammatory substances in the body, such as histamine and kinin, are released during cold virus infection, causing nasal blood vessels to dilate. Runny nose results from two different inflammatory events, nasal mucus gland secretion and leakage of fluid from nasal blood vessels. Nasal mucus gland secretion is triggered by the nervous system's response to cold virus infection. Fluid leakage from nasal blood vessels results from the action of histamine and kinin.
- Sneezing results from a reflex that originates in the nose, passes through the brain and activates the diaphragm and muscles in the chest. Antihistamine treatment blocks sneezing associated with colds, suggesting that histamine has a role in causing this symptom.
- Sore throat occurs when pain nerves in the throat are stimulated. Kinin, a potent stimulator of pain nerves, is released during colds.
- Cough results from another reflex that can be triggered by an inflammatory mediator produced in the body called prostaglandin.
- General cold symptoms, such as headache and not feeling well, are associated with interleukin, another inflammatory mediator.

The present clinical study was based on this new understanding of what causes cold symptoms. One ingredient of the treatment was the antiviral drug—interferon, which attacks the virus infection itself. Interferon is a natural protein of the body that makes cells resistant to cold virus infection for up to 24 hours In the new treatment, three doses of interferon were given intranasally at 12-hour intervals.

The other two treatment ingredients treated the inflammatory pathways that cause cold symptoms. Chlorpheniramine is an antihistamine and anticholinergic, which blocks sneezing and runny nose. The other ingredient, ibuprofen, reduces sore throat, coughing and headache, because it — like other non-steroidal, anti-inflammatory drugs — blocks the action of prostaglandin. Treatment with these drugs also reduces coughing.

In the study, the chlorpheniramine and ibuprofen were given orally at 12-hour intervals for the duration of the illness. Treatment with all three ingredients started in the early stage of the cold

The researchers tested the treatment in a double blind, placebo-controlled clinical trial in 150 young male and female adults. During the five days of the study, the daily average total symptoms score of volunteers receiving the actual drugs were reduced by 33 percent to 73 percent compared to those on non-active placebo treatment. Volunteers who received the actual drugs experienced reduced severity of sneezing, runny nose, nasal obstruction, sore throat, cough and headache They also had less nasal mucus production, nasal tissue use and virus concentration in nasal secretions

The study showed that adding interferon to the treatment made it more effective than chlorpheniramine and ibuprofen alone. The side effects associated with the treatment were drowsiness, which occurred in 9 percent of volunteers on chlorpheniramine, and none of those on placebo. Mild blood-tinged nasal mucus occurred in 19 percent of subjects on interferon and 10 percent of the subjects on placebo. No side effects led to discontinuation of treatment.

According to the team leader, the new method for treating colds is more effective than symptomatic cold treatments or antiviral treatment used alone.

Ulcer Bacteria Linked To Strokes

The report of a research study conducted under the leadership of Antonio Pietroiusti, M.D., a professor of internal medicine at Tor Vergata University in Rome have found that potent strains of ulcer-causing bacteria may play a key role in certain kinds of stroke, researchers report in today's rapid access issue of Circulation: Journal of the American Heart Association. Researchers have found for the first time, that specific strains of Helicobacter pylori (H. pylori) were much more prevalent in the blood of patients who have suffered an atherosclerotic stroke. Some studies have linked H. pylori with inflammed artery walls and arterial lesions, including stroke caused by narrowing of the arteries due to atherosclerosis.

H. pylori causes ulcers in the stomach. In large arteries leading to the brain, the researchers report that cytotoxin-producing strains of the bacteria appear to aggravate an already risky environment The cytotoxin-associated gene-A (CagA) makes strains of H pylori virulent and especially damaging to arteries. Cytotoxins attack cells, causing tissue inflammation and ultimately lesions. By attacking vulnerable areas of the artery wall, they cause inflammation and swelling, further restricting blood flow and increasing the chance of stroke.

Researchers compared different strains of H pylori in the bloodstream of 138 patients with large-vessel stroke (group A); 61 patients with cardioembolic stroke (group B); and 151 healthy volunteers. Extensive atherosclerotic changes cause large vessel strokes, says Pietroiusti. Cardioembolic strokes are caused by abrupt blockage of a cerebral artery by a clot that travels to the brain.

Prevalence of H. pylori infection among patients with large-vessel and normal controls was about the same. However, the presence of CagA-positive strains were significantly higher in large-vessel stroke patients than the cardioembolic stroke group — 42.8 per-cent versus 19.7 percent. It was also higher than those of the controls — 17.9 percent. Researchers found that only CagA-positive strains of H. pylori are associated with ischemic stroke, and that this association is confined to patients with atherosclerotic stroke. C-reactive protein (CRP) levels, a measure of systemic inflammation, were also higher in both stroke groups compared with controls. But patients with CagA-positive strains of H. pylori had the highest CRP levels, indicating more severe inflammatory response.

Researchers theorize that the virulent H. pylori may increase system-wide infection, which is known to increase atherosclerosis. Increased infection may also contribute to plaque instability. Unstable plaque can rupture and send a blood clot to the brain, resulting in an ischemic stroke

Researchers Identify Enzyme that Turns on RNA

Scientists have long searched for triggers that activate ribonucleic acid (RNA), a key component in gene expression. A group of scientists from the University of Wisconsin Madison, USA hase reported that they have found an enzyme that activates RNA, which could lead to new ways of regulating genetic information. The research team comprised Judith Kimble and Liaoteng Wang, as well as Marvin Wickens and Christian Eckmann from Biochemistry Department of University of Wisconsin-Madison. According to Judith Kimble, a Professor of Biochemistry and a senior member of the team of investigators, one of the major issues in molecular biology is how genes are controlled. The research finding provides an important piece of the puzzle.

Inside the nucleus of every cell are genes, which are composed of deoxyribonucleic acid (DNA). This genetic information contains all the instructions cells need to make protein-molecules that enable cells to carry out special functions, such as the transport of oxygen by red blood cells. For these cellular activities to happen, DNA must get copied into RNA, which carry the instructions outside the nucleus to the molecular machinery that makes proteins.

However, Kimble explains if a RNA is not activated, it can get trashed or hidden away. And, if the cell does not have a particular RNA, it would not have any of the protein the RNA encodes. This is how things can go awry, along the way. Wang further adds that a gene won't do any good if it fails to be expressed.

The research team studied the embryonic development of the microscopic worm, C. elegans, and identified two proteins—GLD-2 and GLD-3—that, when bound together to form an enzyme, activate specific RNAs outside the nucleus This activation would enable the RNA to carry out important steps of germ line, or reproductive development, such as the formation of sperm or egg cells. In other words, RNA wouldn't get "trashed."

Wang and Eckmann had been working independently on the different proteins, both of which are responsible for most stages of germ line development Wang studied GLD-2 and found that it had a site where reactions could take place, but that it couldn't bind to an RNA Eckmann, who studied GLD-3, found that his protein could do just the opposite. it could bind to RNA, but didn't have the catalytic site. Kimble explains that Wang and Eckmann started looking for binding partners for their individual proteins and amazingly, they found that GLD-2 and GLD-3 bound to each other. Binding the two proteins together created an enzyme that could not only attach itself to RNA but could also chemically modify the RNA in a specific way that turns it on Explaining further, Kimble says that when regulating biological processes, one does not want to activate all the RNAs in a cell — but to activate only the important RNAs at the right time and in the right place.

Researchers have found homologs, or proteins similar to GLD-2, in other organisms, ranging from yeast to humans. According to Kimble, little is known about these homologs, except their amino acid sequences Proteins similar to GLD-3 have also been found, but only in more complex animals, ranging from worms to humans. Again, how these proteins work remains a mystery.

More and more organisms' genomes have been completely sequenced, but sequences don't tell you the biochemical function of proteins In this study, researchers identified the biochemical function of GLD-2, and, since there are proteins in other organisms that have sequences similar to this protein, we can now make more educated guesses about the function of those proteins.

By identifying this enzyme that regulates how genes are expressed in C-elegans, the researchers claim that it will now be possible for scientists to explore how similar enzymes work in humans, possibly one day leading to new therapies

Researchers Check Brain Waves to Predict Effectiveness of Antidepressants

A new study shows for the first time that measurable changes in the front of the brain can predict the effectiveness of an antidepressant within days of treatment — weeks before a patient begins to feel better.

Using quantitative EEG, a non-invasive computerized measurement of brain wave patterns, the researchers discovered that specific changes in brain-wave activity precede clinical changes brought on by medication The new findings could lead to treatment programs that help depression patients feel better, faster, by cutting evaluation periods from weeks to days. The findings also could aid in the development of new medications.

According to Dr Ian A. Cook, a lead member of the research team, up to 40 percent depressed patients do not respond to the first medication they try Since it takes several weeks for an effective treatment to produce clear improvement, doctors often wait six to 12 weeks to decide that a particular medication just isn't right for that patient and move on to another treatment. By comparing EEG measurements before treatment with those soon after treatment begins, doctors may be able to evaluate the usefulness of an antidepressant within days rather than having to wait for weeks to months. This technique also could slash the time and costs needed to develop and research new antidepressants.

The study examined 51 adult patients diagnosed with acute depression. Each participated in one of two, double-blind, randomized treatment trials. One group received the antidepressant fluoxetine or placebo. The other received the antidepressant venlafaxine or placebo. (A placebo is an inactive substance, such as a sugar pill.) Each subject received a quantitative EEG prior to treatment, 48 hours after treatment and one week after treatment.

Thirteen of 25 subjects, or 52 percent, responded to medication. Ten of 26 subjects, or 38 percent, responded to placebo. Subjects who responded to medication uniquely, showed significant decrease, in cordance—a measure of brain-wave activity, at 48 hours and one week. Clinical changes did not begin to emerge until after four weeks. Subjects with the greatest changes in cordance had the most complete response to the medication after eight weeks Comparing their findings with those of earlier studies in this field, Dr Cook, an assistant professor in the Department of Psychiatry and Biobehavioral Sciences at the David Geffen School of Medicine at UCLA, USA said that other researchers have compared brain scans of depressed people before and after treatment and found differences between those who recovered and those who did not respond. Those findings, however, do not allow prediction of whether a particular patient is likely to get well. This is the first study to detect specific changes in brain wave activity that precedes the clinical changes in a way that can usefully predict response.

Cook's group proposes to continue their work to determine whether this same pattern holds for other antidepressant medications. They are also working to simplify the EEG method to make it easier for doctors to use this approach in patient care. EEG measurements are performed by placing recording electrodes on the scalp The electrodes connect to the body through conductive paste or gel, which is easily rinsed from a person's hair after the test is complete It does not hurt and involves no radioactivity. The electrodes are connected to a computer, which measures the signals coming from the brain and processes them into colorful patterns

Proteins Behave Differently inside Cells than they Do in Water Solutions

Chemists at the University of North Carolina, USA Hill have shown experimentally for the first time that proteins can behave differently inside cells than when taken out of those cells and studied in test tubes. These findings, they believe are fundamentally important to both biology and medicine.

Dr Gary Pielak, Professor of Chemistry and leader of the study team asserts that their research work demonstrates that proteins need to be studied under the conditions they are found inside the cell. According to him, scientists thought they can learn everything about proteins by studying them in water, but the work done by the researchers shows that they have been missing important observations by looking at them just in water or other solutions

The research is relevant to medicine because the protein is related to proteins associated with Parkinson's and Alzheimer's diseases and cancer, the scientists say Proteins are the robots of the cell in that they perform countless functions including allowing cells to grow and reproduce. Almost everything scientists know about them comes from research done in test tubes in water solutions. But inside cells, where proteins work, there are no dilute solutions because the interior is crowded with proteins, which take up about 40 percent of the volume.

Working under Pielak's supervision, Matthew Dedmon used nuclear magnetic resonance (NMR) spectroscopy to examine what effects the crowded environment had on protein shape because the shape of a protein determines its function. The team found that a so called "intrinsically unstructured" protein, which in water appears to have no fixed structure, shows a definite folded-up shape when inside cells. Among other things, the experiments involved measuring the proteins with a nucleus of nitrogen known as N-15 and then recording and comparing their NMR spectrum both inside cells and outside cells under artificially crowded conditions.

Scientists had theorized for many years that solutions crowded with molecules would tend to favour molecular shapes that had the smallest surface areas. In some ways, the explanation of the newly discovered observation, according to Pielak, has been around for two centuries - since the time of Le Chatelier. In the past, however, it has been so difficult to do these experiments that few have even tried. With the new information pouring in from the Human Genome Project and other efforts to identify genes, scientists hope to create models of cellular metabolism, which would advance understanding of health and illness.

However, to make a model of cellular metabolism that would run in a computer, one need to know how tightly these proteins bind to one another and how fast they bind. All those data so far are from solutions that were mainly water. If there are differences between what one measures in dilute solutions and what occurs in cells, no one will ever be able to model metabolism. That means there is a need to look more thoroughly at the conditions found inside cells and measure them.

The most impressive aspect of the discovery, the researchers say is the clear demonstration that the environment of proteins in real life situations —the proximity of billions of other molecules such as lipids, sugars, salts and water, for example —has a profound influence on their three-dimensional structure. Everyone knows that this three-dimensional structure is essential in biology, but very few investigators have had the courage to look at proteins in the complex soup they actually live in.

Engineers Model Blood Flow

A computer simulation that shows how branches and bends in blood vessels disturb smooth-flowing blood and contribute to heart disease has been built by researchers at the University of California, USA. Eventually, it could be possible to use such models to predict the risk of some types of heart disease. Every minute, at rest, the heart pumps out about five litres of blood. The swirls and eddies of that blood could help determine where fatty plaques build up, damaging blood vessels and eventually leading to heart disease.

Mechanical engineers Abdul Barakat and Harry Dwyer, mathematician Angela Cheer and post-doctoral researchers Nader Shahcheraghi and Thomas Rutaganira built the model by studying CAT scans of the aorta, the major vessel carrying blood from the heart

Every biology student knows that the aorta rises out of the heart and then bends over, in a candy-cane shape, taking blood to the abdomen and the legs. Three major arteries branch off the top of the bend, taking blood to the upper body, head and to the heart itself.

The model shows how disturbed flows form in places such as the inside wall of curves and around branch points According to Barakat, disturbed flows could pray a role in the early stages of atherosclerosis, when fatty plaques form on the blood vessel walls. However, it is the oscillating flows, where the blood swooshes back and forth, which seem to cause the most damage. The computer models can predict where this effect is likely to happen under different conditions.

Aorta shape varies slightly between individuals and could be an inherited risk factor for heart disease, Barakat said.

Eventually, it could be possible to

image a patient's aorta by CAT scan, put that image into a computer model and see how it performs under different conditions, allowing doctors to assess the risk of atherosclerotic disease due to disturbed flows.

How to Remove 250 Stains from Clothes and Textiles

To remove a grass stain, would you use banana oil, detergent, ammonia, vinegar, alcohol or bleach? Or, would you just give up?

Textile Experts at Cornell University, USA have published literature that provides laboratory-tested details on removing almost 250 different stains, from adhesive tape and antiperspirant to wax crayon and wine with products that can be found in most grocery stores or pharmacies. The information can be accessed online in Adobe Acrobat format at - http://www human cornell edu/units/txa/extension/removing stains.pdf

According to Judy L. Price, a retired extension educator from Monroe County, USA, every single stain has been tested, and if the directions are followed, the chances of removing the stains are very good. The present publication is an updated version of a 1975 Cornell publication titled 'Removing Stains at Home'.

The 12-page booklet includes descriptions of the various supplies needed for stain removal, such as solvents (dry-cleaning solvent, paint-, oil- and grease-remover and amyl acetate); lubricants for water-borne stains, such as detergent, glycerin and sprays; lubricants for oil stains, mineral oil; and acids and alkalies such as ammonia and vinegar, bleaches, and enzyme products. It includes specialized procedures for stains such as ballpoint ink, black walnut, candle wax, evergreen pitch, grass, lipstick, rust and scorch marks

What about the grass stain? The correct answer is all of the above! Blot first with banana oil (amyl acetate), then blot with detergent solution and flush with water; blot with ammonia solution and flush with water, blot with vinegar solution and flush; sponge with alcohol, blot and flush, remove final traces with bleach solution as many times as it takes, flushing with water after each application; apply vinegar solution to remove excess chlorine, then flush with water It works most of the time, especially if the stain is fresh

Compiled and edited by R. Joshi

Book Reviews

A Biographical Account of J.C. Bose

Jagdish Chandra Bose —
The First Modern Scientist
Dilip M. Salwi
Publisher: Rupa & Co.
7/16, Ansari Road, Daryaganj
New Delhi 110 002
Pp. 59, Rs 95.00

JAGDISH Chandra Bose is more renowned for his work in botany. Using indigenously fabricated instruments, he could show that plants have feelings like us human beings. Using 'Crescograph' he could also measure the rate of growth of a plant. However, Bose was one of the pioneers of wireless telegraphy — a technology for sending messages via radio waves without the use of wires.

Following Maxwell's theoretical prediction that radio waves (more precisely-electromagnetic waves) exist. Heinrich Hertz was able to produce them experimentally in 1887. In due course, several physicists also started taking interest in radio waves. Among these researchers, mention may be made of the British physicist Oliver Joseph Lodge, the French physicist Edouard Branly, the Russian investigator Alexander Stepanovich Popoy and the Italian physicist Guglielmo Marconi.

Inspired by the lecture of Oliver Lodge and his book titled "Heinrich Hertz and his Successors", Bose also became interested in the subject of radio waves. It was the year 1894 which, incidentally, coincided with the 36th birth anniversary of Bose. On this occasion, Bose took an oath to devote his entire life in the service of science. Bose was then working as a Professor of Physics at the prestigious Presidency College, Calcutta (now Kolkata). Bose started his experiments on wireless telegraphy in the small laboratory space of hardly two-and-a-quarter square metres allotted to him by the College

Working in his laboratory, Bose designed and fabricated a novel type of 'radiator' for the generation of radio waves. He also made highly sensitive radio receiver or detector, called 'coherer', to catch these waves.

Using his equipment, Bose was able to generate a special type of radio waves, with wavelength in the millimetre range, now called microwaves. In 1895, Bose successfully gave the public demonstration of his radio waves in the Town Hall of Kolkata in the presence of the Lieutenant Governor of Bengal, Sir William Mackenzie. He was able to transmsit radio waves to a room situated at a distance of 25 metres from the lecture hall and connected to it through intervening walls.

In 1896, Guglielmo Marconi, who was also working in the field of radio waves, got his invention patented. Infact, inspired by the work of the Russian investigator A.S. Popov, Marconi was attempting to generate radio waves that could travel longer distances.

In 1907, Marconi using his sophisticated receiver (which, it is alleged, was inspired by the Bose's detector coherer) could send radio signals across the Atlantic Ocean. This created an immense sensation in the entire world that made Marconi famous overnight. For his work on wireless telegraphy, Marconi was awarded the Nobel Prize for Physics, which he shared with the German physicist Carl Ferdinand Braun in 1909.

It is indeed ironical that despite Bose's pioneering role in the field of radio waves, he was not given proper credit for his work It is now generally accepted that Marconi could never have succeeded in his trans-Atlantic transmission, for which he got all the credit including the Nobel Prize, had he not used the detector which was merely an improved version of Bose's coherer. At least Marconi should have shown some grace by acknowledging Bose's contribution.

However, Bose himself was also partly responsible for not getting due recognition for the work he did on radio waves. One reason was that he refused to patent his invention Also, he abandoned his research on radio waves around 1900 and moved to other fields, specially botany He also failed to found a school of radio research in which his students and disciples could have continued doing work on radio waves. Last, but not the least, Bose carried out his research single-handedly. He never chose to co-author any papers in physics either with his students or peers.

Besides inventing sensitive detector called coherer, Bose had also developed a unique detector using crystal of a lead mineral known as 'galena'. It was perhaps the first use of a semiconductor as a detector.

One of the founding fathers of radio-physics, Bose was undoubtedly the pioneer of the modern Indian science. He was the first Indian scientist who showed to the western world that Indians too are capable of doing modern science.

The work and struggle of J.C. Bose including his contributions in the fields of radio-physics and botany have been brought home in the biography (under the Charitavali series) under review.

As the book would have us believe, in his struggle Bose always derived inspiration from one of the Mahabharata heroes, Karna, who, according to him, always suffered defeats despite talents, abilities and sacrifices. Karna's life only taught him that success is always small and failure is great. He, therefore, trained his mind in such a way as to forget the difference between success and failure. In this context, Bose once said "If there has been any success in life, that was built on the unshakeble foundation of failure..."

The book starts with Bose's public demonstration of radio waves in the Town Hall of Kolkata in 1895. After giving the biographical account of Bose, the book moves on to Bose's work on radio waves The fourth chapter of the book 'From metals to plants', describes the shifting interest of Bose to plant research. The final chapter gives an account of the creation of Bose Institute.

The book has been written in simple and in an easy-to-follow style The quality of paper used and the overall production of the book are both excellent. However, some discrepancies, may be printing mistakes, have inadvertently crept in the book. On p.12 it is stated that Bose was sent to "St. Xavier's School in Kolkata". However, on p.57, it is written that Bose was admitted to the "Hare School, Kolkata". There is another mistake on p.26, instead of the "Lieutenant Governor of Kolkata" it should be the "Lieutenant Governor of Bengal". Finally, on p.53, it is stated that Bose breathed his last at Giridih, "a hill station near Kolkata". The precise and correct statement should be "a hill station in Bihar (now Jharkahnd)"

The struggle and perseverance of Bose brought home in the biography under review, will be able to inspire young readers and motivate them to take up careers in science

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Book Reviews

The Exotic World of Liquid Crystals

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Crystals abound in nature. However, they are generally solid and rigid Their physical properties, e.g., mechanical, thermal, electrical and optical, also vary with direction. The crystals are, therefore, *anisotropic* in nature. On the other hand, liquids are *isotropic* as their physical properties do not depend on the direction.

With properties of liquids and crystals so divergent, how does one reconcile with the concept of a liquid crystal? In order to understand this we will have to look closely at the arrangement of molecules in liquids as well as crystals.

The molecules in a crystal are arranged in a very regular and orderly fashion. The forces between the molecules give the crystal its rigid structure. On the other hand, a liquid has no definite structure, as the forces operating between its molecules are quite weak. This is why the molecules of a liquid can freely move around within its boundaries. A liquid, therefore, takes the shape of the container in which it is placed.

The liquid crystals may seem strange and new, but they have been known for more than a century now. It is another matter that for a long time they seemed to have no practical applications Only in the mid-twentieth century, after advancements had been made in other fields of technology, did the scientists thought of putting them to practical use.

The German physicist Otto Lehman was the one who, in 1899, first discovered materials with crystal like properties and gave them the name — liquid crystals The most familiar example of liquid crystals is the soap bubble Many parts of the human body, such as the materials surrounding the nerves, possess the liquid crystal properties.

It has been observed that many substances, most of them being organic crystalline solids, on being heated do not directly go to the liquid phase. In fact, they pass through an intermediate liquid-crystal phase as they undergo transition from the solid to the liquid phase. In this intermediate state, they behave like liquids, however retaining their highly anisotropic properties. So, a liquid crystal may be said to be a mid-way state between the solid and the liquid states.

The liquid crystals show resemblance to both liquids and solids. Like the molecules of a liquid, the liquid crystal molecules can move around freely, but they tend to remain in larger groups as in a crystal. Thus, a liquid crystal is usually thick and flows slowly This is because the molecules of a liquid crystal are rod-shaped and have strong electrical charges of opposite signs at either end, giving rise to an electrical attraction between the molecules. The molecules are, therefore, lined up in definite patterns even in the liquid state.

The crystalline structure exhibited by liquid crystals, in fact, depends upon their 'lining up' effect; the more the molecules line up, the more crystalline the material becomes.

When a liquid crystal material is spread in the form of a thin sheet, comprising only a few layers, the molecules in these layers are lined up so rigidly that they hardly have any motion at all. The behaviour of the material then comes very close to an actual crystal.

Unlike a solid crystal, however, a liquid crystal is not stable This is because it lies on the border line between a liquid and a solid and so the arrangement of its molecules get easily changed from one pattern to another with time.

The external factor can, therefore, easily affect the behaviour of a liquid crystal material. For instance, a small rise in temperature, a slight pressure variation or a minute change in the electric current may alter the observed behaviour of a liquid crystal and produce changes in it.

By controlling these changes, the scientists have put the liquid crystal materials to a plethora of uses. A liquid crystal, for instance, may be sandwiched between two thin glass plates As the molecules of the liquid crystal are lined up in an orderly way, it is transparent to the light which passes through it undeviated or unreflected. However, if a small current be passed through such a liquid crystal, its molecules may break apart, i.e., their arrangement undergoes a change. As a consequence the light incident on it may now get scattered and the liquid crystal becomes opaque. Therefore, walls of liquid crystal glass panels can be made transparent or opaque at the flick of a switch. Sounds bizarre? However, these possibilities are no longer confined to the imagination of science fiction writers but are already being used for many purposes, especially in some developed countries like Japan.

If instead of passing the current through the entire body of the material, the current be passed selectively, say, for example, only through certain parts of the crystal which are shaped like numbers or letters, then those points will become opaque due to the passage of the current. The outline of letters or numbers can then be made to glow and easily read. This is an important property of liquid crystals which has been used in making digital clocks, watches and calculators — the devices commonly known as Liquid Crystal Displays (LCD).

In some hospitals, liquid crystals have been put to use to monitor the body temperature of babies. The liquid crystal taken in the form of a disc is placed on the body of a baby. The disc changes its colour depending on the body heat enabling the temperature to be monitored.

In medical science too, liquid crystals may have potential applications. Materials of liquid crystal coated on the patient's skin can be used for detecting any underlying tumors.

Flat television sets not thicker than a picture frame have also become a reality, thanks to the liquid-crystal technology.

However, in the field of liquid-crystal technology, many problems still remain to be tackled. One ticklish problem with liquid crystals is that they are too much sensitive to change and so are very difficult to manipulate and control. They also do not tend to last long as they get impaired very quickly. Nevertheless, liquid crystals have already made their niche and are proving to be of increasing interest in a number of scientific fields. On the research front as well as the area of technology, the bizarre world of liquid crystals has indeed much to offer.

Galvanic Corrosion – An Electrochemical Series Teaching Activity

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GALVANIC corrosion is one of the commonly encountered forms of corrosion and occurs when two dissimilar metals are in contact in an electrolytic solution (1–5). Failure of bimetallic joints is mainly due to this type of corrosion (3). But, the phenomenon has been used to advantage for protecting steel against corrosion by galvanisation and other metallic coatings (6). Since the process of galvanic corrosion is due to difference in reactivity of metals, it can be used as a classroom demonstration to explain electrochemical series and its applicability. Keeping this in view, the author has carried out some experiments pertaining to galvanic corrosion, without involving any measuring devices, and using simple systems. The basic purpose of this communication is not to go into the details of galvanic corrosion but to use the phenomenon as a teaching aid to explain the relative reactivity of metals in the light of electrochemical series

Theoretical Background

Galvanic corrosion is a specific case of heterogeneous corrosion (2) in which two different metal pieces are involved in the process. The corrosion current (I_c) due to dissolution of the less noble metal (I_m) is balanced by the electronation (cathodic) current (I_e) at the more noble metal (7)

$$I_c = I_m = -I_e$$

The extent of corrosion depends on the area ratio (Aa/Ac) of the two metals at which the anodic and cathodic reactions are occurring.

The electrochemcial reactions occurring at the coupled metals depend on their potential values. The de-electronation process leading to metal corrosion occurs at the metal having lower potential and electronation takes place at the higher potential metal. Furthermore, depending on the solution pH and O_2 saturation, the reduction process (electronation) may be either the reduction of O_2 or that of H^+ (2). The following electronation reactions are usually observed·

De-electronation

$$M \longrightarrow M^{n+} + ne^- \qquad (1)$$

Electronation

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$$

(In neutral or basic solution) (2)

$$\text{or } O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O \qquad (3)$$

(In acidic solution)

$$\text{or } 2H^+ + 2e^- \longrightarrow H_2 \qquad (4)$$

(In acidic deoxygenated solution)

In the acidic O_2^- dissolved solution, O_2 reduction and H^+ reduction may occur simultaneously. Occurence of the above processes can be demonstrated using metal couples having large potential difference, such as Zn-Fe, Mg-Fe, Fe-Cu and comparing their behaviour with the uncoupled metals. Hydrogen gas evolution occurs in reaction (4) and OH^- ions are generated when reaction (2) is the reduction process OH^- ions may react with the metal ions to produce $M(OH)_n$ precipitate No such visible change is observed when reaction (3) is the reduction process.

Experimental Procedure

For the galvanic corrosion experiment, Mg - Fe (0 3 × 6 cm - 0.3 × 6 cm), Zn - Fe (1 × 6 cm - 1 × 6 cm), Fe - Cu (1 × 6 cm - 1 × 6 cm) couples were used Commercial grade metal samples were taken. The metal strips were abraded with 320 grade carborundum paper. They were then chemically cleaned, washed with distilled water and immediately stored in a desiccator after rinsing with methanol.

Corrosion experiments were carried out in 6% NaCl solution, prepared in distilled water. This concentration of NaCl was chosen to have accelerated corrosion process so that detectable changes could occur in short duration and the demonstration could be used as a classroom teaching aid. 20 mL of the solution was taken in a test tube (15 cm length, 1.5 cm I.D.) and the couple strips, tied together with a thin rubber band, were dipped in it for about 45 minutes. The strips were under a depth of about 5 cm in the test solution. Mg - Fe, Zn - Fe and Fe - Cu metallic couples were thus put in three test tubes, each containing about 20 mL of NaCl solution

Changes, such as, gas evolution, etc , occurring in the systems, were recorded. The corrosion products formed during corrosion of the coupled metals were tested chemically by taking about 1 mL of the solution. Fe^{3+}_- presence was checked with $K_4Fe(CN)_6$ after acidifying the solution with 2-3 drops of concentrated HCl. In the case of Mg-Fe and Zn - Fe couples, white precipitates are formed, which were identified as $Mg(OH)_2$ and $Zn(OH)_2$, respectively, using qualitative tests. For the Fe - Cu couple, Cu^{1+}_- presence was checked with KSCN solution Corrosion behaviour of uncoupled Mg, Fe and Zn strips was also observed under similar experimental conditions to compare the effect of galvanic coupling on metallic corrosion

Conclusions regarding the process occurring at the coupled metals were drawn on the basis of visual observations and qualitative analysis results. No weight-loss or other quantitative measurements were carried out.

Results and Discussion

The galvanic corrosion behaviour of Mg-Fe, Zn - Fe and Fe - Cu couples was as expected on the basis of electrochemical series predictions No corrosion of Fe was seen in Mg - Fe and Zn - Fe couples since Fe acts as a cathode. But, in case of Fe - Cu couple, Fe corroded at a accelerated rate in comparison to uncoupled Fe - sample and a brown precipitate was formed, which on testing with $K_4Fe(CN)_6$ indicated it to be $Fe(OH)_3$. The processes involved in $Fe(OH)_3$ formation have been explained by Uhlig (8).

In Mg – Fe couple, having a potential difference of 1.93V, Mg acts as anode in the couple and protects Fe against corrosion. Gas bubbles are seen at Mg and a white precipitate due to formation of $Mg(OH)_2$ appears. H_2 gas bubbles generation at Mg occurs due to impurities present in the metal (9). This causes the local cell formation and leads to self-decay of Mg. Self-decay with visible hydrogen generation was also observed on immersing Mg strip in NaCl solution.

In Zn - Fe couple, Zn, having more negative potential, acts as anode in the galvanic couple and protects Fe against corrosion, which behaves as cathode. Besides acting as anode in the galvanic couple, Zn undergoes self-decay also with H_2 evolution (6), as was seen in case of Mg. A white precipitate due to formation of $Zn(OH)_2$ appears in solution.

The observations made with Mg-Fe, Zn - Fe and Fe - Cu couples are explained by considering the following reaction sequences:

At Mg-Fe Couple

$$Mg \longrightarrow Mg^{2+} + 2e^- \quad \text{(Galvanic corrosion)} \quad (5a)$$

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^- \quad (5c)$$

$$Mg \longrightarrow Mg^{2+} + 2e^- \quad \text{(Self-decay)} \quad (6a)$$

$$2H_2O + 2e^- \longrightarrow 2OH^- + H_2 \quad (6c)$$

$$Mg^{2+} + 2OH^- \longrightarrow Mg(OH)_2 \quad (7)$$

At Zn-Fe couple

$$Zn \longrightarrow Zn^{2+} + 2e^- \quad \text{(Galvanic corrosion)} \quad (8a)$$

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^- \quad (8c)$$

$$Zn \longrightarrow Zn^{2+} + 2e^- \quad \text{(Self-decay)} \quad (9a)$$

$$2H_2O + 2e^- \longrightarrow 2OH^- + H_2 \quad (9c)$$

$$Zn^{2+} + 2OH^- \longrightarrow Zn(OH)_2 \quad (10)$$

At Fe-Cu couple

$$Fe \longrightarrow Fe^{2+} + 2e^- \quad \text{(Galvanic corrosion)} \quad (11a)$$

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^- \quad (11c)$$

$$Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2 \quad (12)$$

$$Fe(OH)_2 + \frac{1}{2} H_2O + \frac{1}{4} O_2 \longrightarrow Fe(OH)_3 \quad (13)$$

At Fe (Uncoupled)

$$Fe \longrightarrow Fe^{2+} + 2e^- \quad (14a)$$

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^- \quad (14c)$$

$$Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2 \quad (15)$$

$$Fe(OH)_2 + \frac{1}{2} H_2O + \frac{1}{4} O_2 \longrightarrow Fe(OH)_3 \quad (16)$$

Reaction schemes for Fe and Fe-Cu couples suggest the formation of $Fe(OH)_3$ precipitate during their corrosion. This is in accordance with the observations made during their corrosion in NaCl solution Behaviour of Mg-Fe and Zn-Fe also agrees with the proposed reaction schemes for these systems.

Conclusion

Zn and Mg metals, having lower potential values, undergo oxidation when coupled to Fe, which has higher potential value. On the other hand, Fe acts as the anode in the Fe-Cu couples due to its potential being less than that of Cu. Since the corrosion behaviour of these galvanic couples is in accordance with the electrochemical series predictions, they can be used for explaining the correlation between the reactivity of metals and their potential values.

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On the Curved Earth Surface with Physics

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A COMMON question on flatness of any plane surface lying on the flat surface of the earth, especially, plane in the flatness of the plane uniform sea-surface is ignored even when there is a need for its consideration. As we realise from the property of the fluids, the sea-water presumably should be settled exactly along the tangential lines of the curved earth surface. Flatness of earth surface, although, may be varying locally due to the different topographical features. The problem of the curvature of the earth surface may not be appealing initially. It is because ordinarily we never realise such hidden facts. If we tease our gray matter a little bit such questions will drag us to generalised coordinate systems. Although it is very easy to see and explain to youngsters by giving the definitions of planes using straight lines and the surface bound by the intersection of straight lines. But, the same question may ridicule you quite a bit when you take into account the actual surface of the earth on which the plane is resting. As the surface of the earth, apparently plane and flat, to the ordinary observers is not flat and plane in itself. We ordinarily are not able to detect the straight lines drawn on the surface as curve ones. On the other hand the possibility of absolute flat surface are not ruled out. However, the probability of such absolute flat planes and straight lines is very low. The reason is—the common man's vision is adjusted to the curvature of the earth surface to perceive them as straight and flat planes. Observing them as perfectly tangential and straight is a self-imposed problem!

In this article an attempt has been made to compare the extent of visible distance in relation to the curvature of the earth. Comparisons have been made between routinely-dealt objects with respect to the curvature of the earth surface. Later on it treats the effects that are obvious due to the curvature. So the ignorance to the curvature and curvilinear coordinate systems can be disastrous and lead to failures. In the practical situations one must use the most general coordinate systems (e g. spherical, etc.) with curvilinear coordinates.

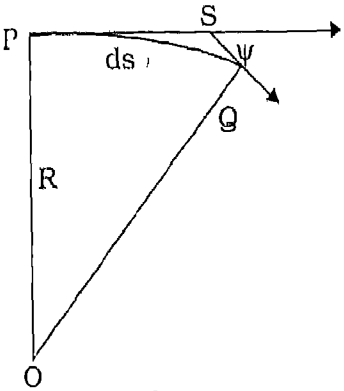

Fig. 1

The rate at which a curve (the various quantities are shown in Fig. 1) curves is mathematically given by

$$\chi = \frac{d\psi}{ds} \qquad (1)$$

and the radius of curvature

$$R = \frac{ds}{d\psi} \qquad (2)$$

the change in direction is $d\psi = \frac{ds}{R}$

which is corresponding to a linear shift

$$\Delta x = ds.d\psi \qquad (3)$$

Now, this gives the orders of magnitudes of deviations from the straight line. Even if seen carefully this negligible deviation can never be detected by naked eye.

The extent of deviation for

1 m is 0.1567×10^{-3} mm
1 km is 0 1567 mm

Obviously, such deviations are not detectable even with very sensitive instruments

But, the effects of the curvature are realised in many practical applications nowadays Line of sight (LOS) propagation of the electromagnetic waves is one of the typical examples of the curvature effect of the earth surface It is very well-known that the area coverage of the transmitted waves is dependent on the antennae heights

Breaking of the tidal waves near the seashores and their envelopes is clearly indicative of the curved surface of the earth. Envelopes having concave inner surfaces towards the free-end are manifestation of the tides over a curved surface.

Any moving object on the surface of the earth is quite likely to show the tendency to leave the ground with the increase in speed. This is simple to understand when the curvature effect of the earth surface is taken into account. Motion in the curved path gives rise to the centrifugal force in the upward direction It remains balanced till it is less than the downward gravitational force.

The equations are like

$$\frac{mv^2}{R} = mg$$

thus, the velocity is given by

$$v = \sqrt{gR} \qquad (4)$$

which is analogous to the orbital velocity and is $\frac{1}{\sqrt{2}}$ times the escape velocity.

Has anyone noticed carefully the apparent motion of long trees such as date palm very far from the speeding train? This also is a very fine example of the curved earth Unlike the near objects which seem to pass by in the opposite direction with same velocity But the far objects tend to move in the same direction and noticed for long time. The following figure (Fig. 2) would explain the curvature effect quite clearly

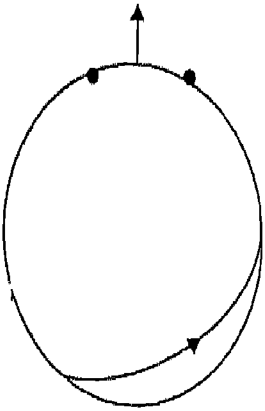

Fig. 2

In Fig. 2 the dark line with an arrow head is the position of the moving train and the dark spots are the very far observable objects which would show an approach towards objects. The observed approach is also clear in curved path in the same direction of motion of the train. This aspect is also clear from Fig. 2.

The coriolis component (i.e. the component of force or acceleration in the direction of the curved path) in case of the moving objects on the rotating curved surface/frame are important factors of consideration in actual calculation of all the dynamical aspects.

Nowadays, all targets such as the enemy installations, very relevant at this juncture (this article took shape at the time of America's war against global terrorism), can be precisely pin-pointed by the use of Global Positioning System (GPS) measurement on the surface of the earth All measurements on the GPS are invariably based on the spherical polar coordinates taking the curvature effect.

The subject of Geodesy, the science of earth surface in relation to assumptions of flat surfaces and straight lines, takes care many aspects of curvature effects. The Geodesy incorporates the necessary corrections. However, the realisation of the curved earth surface with physics is a matter of interest.

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Application of Boolean Algebra in Switching Circuits

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BOOLEAN Algebra is an algebraic structure which is based on the principles of logics George Boole (1813-1864) published a research paper named *Laws of Thoughts* which are used to define an abstract mathematical structure called Boolean Algebra which is named after this great mathematician.

First, a logical problem is represented by a Boolean Algebra, then the rules of Boolean Algebra are applied to the problem and a solution to the original problem is obtained. Claude E. Shanon was responsible for the application of Boolean Algebra to switching networks

Let B be a non-empty set equipped with two binary operations **+** and ; a unary operation ' and two distinct elements **0** and **1**. Then B is called Boolean Algebra if the following axioms hold for elements a, b, c in B.

(B_1) $a + b \in B$ and $a . b \in B$ (Closure property)

(B_2) $a + b = b + a$
and $a \quad b = b \cdot a$ (Commutative property)

(B_3) $a \cdot (b + c) = a \ b + a \ c$
and $a + b \ c = (a + b)\ (a + c)$ (Distributive property)

(B_4) $a + 0 = a$
and $a \ 1 = a$ (Identity laws)

(B_5) $a + a' = 1$
and $a \ a' = 0$ (Complement laws)

The binary operations '+' and '·' used in Boolean Algebra are not the operations of ordinary addition and multiplications The operations '+', '·' and are called sum, product and complement, respectively.

Let B be the set consisting of only two elements, namely 0, 1 and binary operations + and., defined as

+	0	1
0	0	1
1	1	1

Table 1.1

	0	1
0	0	0
1	0	1

Table 1.2

together with unary operation defined as $1' = 0$, $0' = 1$. Then it is easy to check that B = {0, 1} equipped with above operation form a Boolean Algebra. This algebraic system has startling revelations when applied to the Mathematical Logic based on truth values of the statements, i.e. True and False denoted by T and F, respectively. Similarly, analogy of this algebra to the circuit network based on two states, i.e whether switches are closed (on) or open (off), leads us to its significant applications which have been discussed in this exposition. To apply this algebraic system to switching circuits, we make the following identification:

(i) We know that a switch is a two-value device used to control the flow of current in a circuit. We shall use letters $x, y, z, x', y', z', \ldots$ to represent different switches. We assign to each switch x, values 0 or 1. If $x = 0$, we mean that x is open (off) and if $x = 1$, we mean that switch is closed (on). Switch x' denotes that if switch x' is closed ⇔ switch x is closed.

and switch x' is open ⇔ switch x is closed.

It any circuit system, switches used may act simultaneously or independently. Similar switches will be presented by the same letter.

(ii) + operation between any two switches, x and y, denotes that switches are connected in parallel (Fig. 1.1) whose flow Table 1.3 similar to the Table 1.1 is as follows:

Flow table for $x + y$

x	y	$x + y$	
0	0	1	→ Current will flow
1	0	1	→ Current will flow
1	1	1	→ Current will flow
0	0	0	→ Current will not flow

Table 1.3

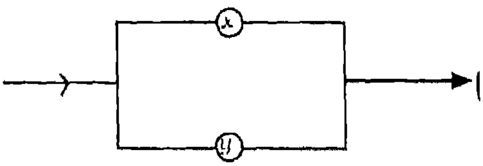

Fig. 1.1

From the Table 1.3, it is inferred that current (Fig. 1.1) will flow if at least one of the switches x and y connected in parallel is closed. This circuit has symbolic representation as $x + y$.

(iii) operation between switches x and y denotes that switches are connected in series (Fig. 1.2) whose flow Table 1.4 similar to the Table 1.2 is given below.

Flow table for x y

x	y	$x \cdot y$	
0	1	0	→ Current will not flow
1	0	0	→ Current will not flow
1	1	1	→ Current will flow

Table 1.4

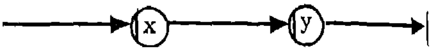

Fig. 1.2

Again from the Table 1 4, it is concluded that the current will flow through the circuit (Fig. 1.2) if both the switches x and y connected in series are closed. Such circuit can be represented symbolically by $x \cdot y$.

(iv) By unary operation, applied to any switch x (say), we mean that switch x' is closed if x is open and switch x' is open if x is closed, i.e.

$$x' = 1 \Leftrightarrow x = 0 \text{ or } x' = 0 \Leftrightarrow x = 1$$

Conclusively, a switch here means a variable and it can take values 0 or 1 according as it is open or closed. Thus the switching system constitute two element set B = {0, 1} depicting the states of switches together with above defined operations +, . and ′ form a Boolean Algebra which is also called Switching Algebra. Thus a switching algebra denoted by ({0,1} +, ., ') is a two-valued Boolean Algebra. Therefore, this Boolean Algebra can be directly applied to the study of behaviour of switching networks

Broadly speaking, application of Boolean Algebra to switching circuits facilitate us in three different ways as described below·

(a) Symbolic representation of the given circuit network.

(b) Designing of the given symbolic representation into the circuit network.

(c) Logical application in the reduction or simplification of the given circuit network

Let us illustrate these with the help of pertinent examples.

Example 1: Express the following circuit network symbolically.

(i)

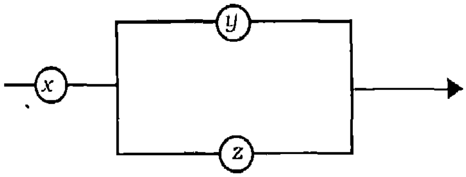

Fig. 1.3

Symbolic representation : $x\,.\,(y+z)$

(ii)

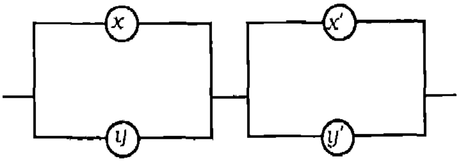

Fig. 1.4

Symbolic representation: $(x+y)\,.\,(x'+y')$

(iii)

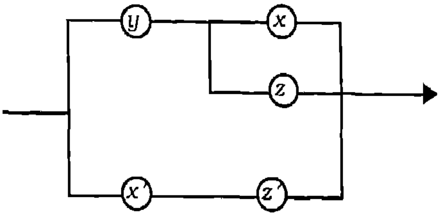

Fig. 1.5

Symbolic representation

$y\ (x+z)+x'\cdot z'$

Example 2· Design the circuit corresponding to the following symbolic representation

(i) $x+y\ z$

Circuit design

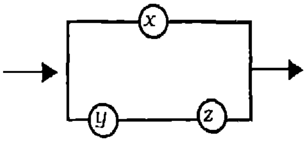

Fig. 1.6

(ii) $(x+y)\cdot(y'+z\ y')$

Circuit design

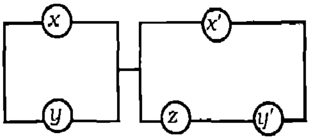

Fig. 1.7

(iii) $(x+y+z)\ (x\ \ y+x'\cdot z)$

Circuit design

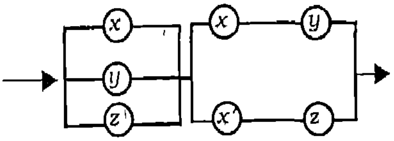

Fig. 1.8

Example 3: Simplify the following circuit networks.

(i)

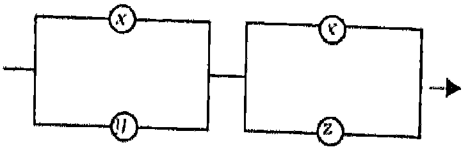

Fig. 1.9

Symbolic representation of the above network is

$(x + y) \cdot (x + z)$

$= x + y \;\; z$ (Distributive property)

Thus the simplified network of Fig. 1.9 is

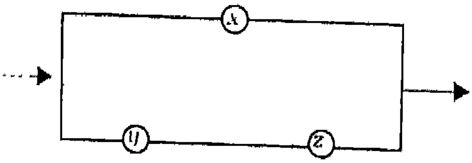

Fig. 1.10

(ii)

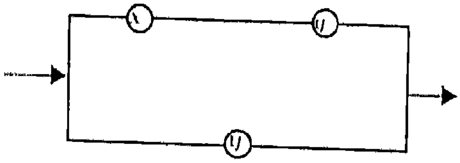

Fig. 1.11

Symbolic representation of the network (Fig. 1.11) is

$x \;\; y' + y$

$= y + x \cdot y'$ (Commutative property)

$= (y + x) \;\; (y + y')$ (Distributive property)

$= y + x$ (since $y + y' = 1$)

The equivalent simpler network is shown in Fig. 1.12.

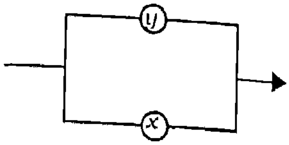

Fig. 1.12

(iii)

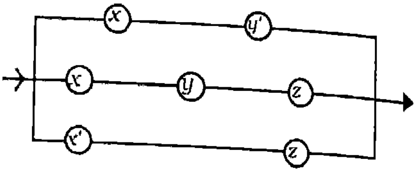

Fig. 1.13

Symbolically the given circuit is

$(x \cdot y') + (x \cdot y \;\; z) + x' \cdot z$

$= x \;\; (y' + y \cdot z) + x' \;\; z$ (Distributive property)

$= x \;\; [(y' + y) \;\; (y' + z)] + x' \cdot z$ (Distributive prope

$= x \;\; (y' + z) + x' \;\; z$ (since $y' + y = 1$)

$= x \;\; y' + x \;\; z + x' \;\; z$ (Distributive property)

$= x \;\; y' + (x + x') \cdot z$ (Distributive property)

$= x \cdot y' + z$ (since $x + x' = 1$)

Hence the simplified equivalent circuit is given in Fig. 1.14.

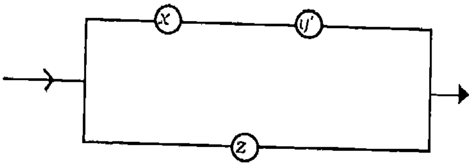

Fig. 1.14

Boolean Algebra has emerged as an indispensable tool for the analysis and design of Logic Circuits. Circuits can be constructed using solid state devices called Logic Gates which are capable of switching voltage levels (bits). Each logic circuit may be viewed as a machine which contains one or more input devices and exactly one output device Input and output signals are in terms of binary digits 0 and 1

There are mainly three logic gates, namely, OR-gate, AND-gate and NOT- gate which have analogies with Boolean Operations +, . and ', respectively Accordingly, Logic Circuits form a Boolean Algebra. Logic gates take inputs of the variables or a combination of variables, work on them in such a way that the output is a Boolean Statements. Boolean Statements help considerably in the development of switching network

Using Power of Atoms and Genes as an Alternative to Bypass Surgery

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STATISTICS reveal that there are more than 3 crore heart patients in India. Despite advances in cardiac cure, coronary ischemic artery disease, i.e. narrowing or blockage of coronary artery by accumulation of fatty material, still remains the most common heart disease today. It is the number one killer of mankind particularly in developed world. We have come a long way from conventional heart operations requiring the breast-bone to be sawed and spread apart, the heart stopped, and blood pumped through a heart-lung machine. Nowadays minimally invasive coronary artery surgery, i.e. keyhole surgery, requires only a three-inch incision. With coming in of new techniques adding precision and speed to both diagnosis and therapy, heart ailments now do not inspire as much fear as they used to, not too long ago. Physicists and molecular biologists through their brilliant innovations of atoms, computers and genes have now devised new methods like thallium test, intracoronary irradiation, robotic surgery and gene therapy which possess high precision and speed to replace conventional risky bypass surgeries. Medical science in its perpetual efforts to harness new technology has not hesitated to utilise the power of atoms and genes. Cardiologists are now increasingly relying on these novelties as an alternative to bypass surgery. It is estimated that one out of every three patients attending a hospital in an industrialised nation benefits from the use of an unstable atom, i.e. radioisotope The energy emitted by unstable atoms undergoing internal change, transferred through space or matter, is called radiation Medical diagnostic scinti-imaging uses these radiations, in the form of X-rays or gamma rays. Since these radiations do not have any mass and electric charge, they distribute energy more diffusely and can easily traverse the tissue targeted.

Techniques using nuclear energy have a unique ability to show bodily functions across time as a film shows picture frames one after the other quickly and accurately The images recorded by the Gamma camera, when received in a fast successive fashion, create a dynamic study of radio-pharmaceutical behaviour, revealing detailed functional information of the concerned organ. For example, the passage of isotope-labelled blood, through heart can be imaged and quantitated to measure the efficiency of the cardiac output, the movement of heart walls and to evaluate congenital defects in the heart causing abnormal shunting of oxygen-poor blood into the general circulation and so on. Most advanced equipment used in the nuclear cardiology is SPECT* It uses increasing power of computers. SPECT is particularly valuable because of its unique ability to locate the exact position of physiological abnormality in the organ by obtaining images from multiple angles. These images depict distribution of a radioisotope within the body/organ. Multiple images obtained through SPECT provide reconstructed images in three-dimensional planes This approach provides better anatomical delineation of a pathology that is possible with planar scintigraphy which provides images in two-dimensional planes

Demonstrating a blocked artery using angiography does not necessarily mean that a patient needs a bypass surgery. It has to be demonstrated beyond doubt that the degree of blockage is severe enough to cause a fall in blood supply to heart muscle Very often patients face a dilemma when different cardiologists have different opinions on bypass after looking at the, same angiogram. Thallium stress test which uses a radioisotope, thallium-201, has proved a boon in decision making in the management of patients with coronary artery disease. This test can help cardiologists to decide whether or when to go for a bypass surgery. Thallium stress test provides an extremely useful and popular adjunct to conventional tests like ECG, holter, doppler and angiography The stress examination with thallium is a diagnostic nucleae medicine investigation used to find out whether the heart muscle is getting the blood supply it needs through coronary arteries or not Preparation of the patient is important for an accurate thallium study. The patient is asked not to eat or drink anything for three or four hours before the test. Some heart medications like beta-blockers and nitrates may interfere with the effectiveness of the investigations and, therefore, are temporarily discontinued before the test. Then the patient is put on a treadmill or a stationary bicycle and the level of exercise is gradually increased appropriate for the patient's age and physical ability. This causes an increase in the heart rate and blood pressure During this procedure, his pulse, blood pressure and ECG are monitored by a trained and experienced physician At this point thallium-201 is injected intravenously which seeps into the heart muscle and its progress can be visualised on a Gamma Camera. It is a sophisticated instrument, controlled by a computer, which provides coloured images of the heart muscle in which the injected thallium has profused From the image one can see which portion of the heart muscle is receiving sufficient blood and which is not Two kinds of procedure are used—planar imaging (flat) in which single images are taken at different angles and sliced imaging (cross-sectional) where the camera rotates around the chest in arc In either case (planar or cross-sectional), the study takes about half an hour After three or four hours of rest, during which light-refreshment may be taken, a second set of images is again acquired No exercise is performed this time. Comparison of the two sets of images of the heart, i.e. the one immediately after exercise and the second after four hours of rest, is performed using sophisticated computer software. Deficiencies of blood flow into the heart muscle are seen as dark spots on the images, as compared to bright areas of normal perfusion. Deficiency indicates the need of surgical intervention in the form of angioplasty. With angioplasty, a doctor inserts a balloon-tipped catheter into a clogged artery to push the blockage aside. The key features of thallium stress test are:

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* SPECT Single Photon Emission Computerised Tomography.

- The test is completely non-invasive and requires only an intravenous injection of radioactive thallium.
- Most of the injected thallium-201 is rapidly cleared from the body by natural processes.
- Radiation exposure to the patient's body is comparable to that from CT* scan. Therefore, the test is avoided in female patients with known or suspected pregnancy.
- Allergic reactions are extremely rare, hence this test is safe as compared to investigations which use iodinated contrast material.
- This test does not delineate individual blood vessels and hence cannot quantify the percentage of blockage in any vessel However, it can highlight the amount of viable heart muscle and can differentiate between temporary, stress-induced deficiency of blood flow
- Though interpretation of the image is aided by computer software, yet it is accurate only in the hands of an experienced nuclear physician, in correlation with other supportive investigation data

Physicists have provided basic know-how to radiation oncologists and cardiologists for developing a new treatment called 'intracoronary irradiation' to prevent resternosis (re-narrowing of coronary artery) after angioplasty which often leads to recurrences of heart attack. Through this method, blocked portion of coronary artery is irradiated with radioisotope, iridium-192R The first Indo-American clinical trial on this new procedure was conducted in e City Hospital of Hyderabad. Dr A M. Naxar Syed, a renowned Brachytherapist has developed a special catheter for irradiating blocked coronary arteries, in collaboration with the United States based Cook Company. This therapy involves dilation of the narrowed part of the affected artery, irradiation of the artery by manually inserting a specially fabricated radio-isotope iridium-192R, through a catheter.

Molecular biologists have now recognised genes responsible for growth of new blood vessels (angiogenesis) and are on the threshold of identifying genes which control genesis of coronary artery diseases. Cardiologists are increasingly making use of these innovations for clinical purposes. The Metro Hospital and Heart Institute, Noida near Delhi has taken the lead in a new treatment called 'gene therapy', for patients suffering from clogged heart arteries In this treatment, new blood vessels are created by injecting gene proteins into the blocked coronary arteries or heart muscle itself A solution of gene protein, known as vascular endothelial growth factor, is made and then it is injected into the affected portion through a porous balloon This gene protein helps in creating new vessels which maintain the blood supply to the affected area On an average 2-3-fold increase in blood flow to the heart can be achieved by this way. This method has shown excellent results in patients suffering from angina. Gene therapy is now tried in patients who are unfit for bypass surgeries, angioplasty or any other aggressive medical treatment It is hoped gene therapy will succeed in replacing extensive bypass surgeries or angioplasties.

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* CT: Computerised Tomography

Invention of Robotic surgery is expected to further revolutionise the field of cardiac surgery The robotic arm acts as the third arm of the surgeon and helps in reducing even the finest tremors which are caused by a surgeon's hand The other benefit of this surgery is that only small incision is made in the chest By using robotic technique the doctor gets a better view of patient's chest, i e three-dimensional vision Robotic surgery is more patient-friendly, as there is less blood loss, lesser pain and the recovery period after the surgery is short.

We may have taken big strides in the field of technology, but the fact remains that with the existing infrastructure we are able to cater to only about one-tenth of what the demand is and, with heavy costs, not too many patients are either encouraged to go for a surgery or for any other kind of medical intervention. Any type of heart surgeries is still considered a luxury with a surgery costing something around one to three lakhs depending on the hospital. It is a vicious cycle

The Golden Star

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The five-cornered star has been in use, from times immemorial, as an auspicious symbol. It is obtained by joining the alternative vertices of a regular pentagon, after its sides are removed. Another way is to extend the sides of a regular pentagon, so as to make it surmounted by isosceles triangles. Five isosceles triangles of equal base and with crest-angle of 36° can be arranged so that each base is aligned with a side of the adjacent triangle and the star is formed. The figure is also called the Golden Star, the reasons for which are explained below:

A line-segment is said to be divided (internally) in the Golden Ratio, if the ratio of the larger part to the smaller part is same as the ratio of the whole segment to the larger part. It was believed, in ancient times, to be the most beautiful division (or the golden division), of a line-segment.

If the larger part of the line-segment is denoted by x, and the smaller part is taken as 1, then, we must have $(x/1) = (x+1)/x$, so that

$$x^2 = x+1 \qquad \ldots (1)$$

This equation is called the Golden Equation It has a positive root a, and a negative root b,

where

$$\left.\begin{aligned} a+b &= 1 \\ ab &= -1 \\ a &= \left(1+\sqrt{5}\right)/2 \\ b &= \left(1-\sqrt{5}\right)/2 \end{aligned}\right| \qquad \ldots (2)$$

This shows that the socalled golden ratio is nothing but

$$a : 1 = (a+1) \,.\, a = 1 : (-b) \qquad \ldots (3)$$

Coming back to the Golden Star, we may suppose that each side of the inner regular pentagon is of unit length. Since the crest-angle of each isosceles triangle is 36°, each equal side of the same is of length $a = \left(1+\sqrt{5}\right)/2$. This implies that every intersection of the golden star is a division in the golden ratio. This justifies the name.

The ancient Hindu astronomer and mathematician Brahmagupta lived and worked during the 7th century, at the astronomical centre at Ujjain. He is credited with the view that assemblages of learned persons ought to recreate themselves by exchanging mathematical puzzles and posers among their honourable members. Questions of that era would probably have been like.

Which number exceeds its reciprocal by 1?

Which number is the reciprocal of its predecessor?

Which number is the square root of its successor?

Which number is the product of its predecessor and successor? If x is the required number, these conditions reduce to

$$\left.\begin{aligned} x-1/x &= 1 \\ x &= 1/(x-1) \\ x &= \sqrt{(x+1} \\ \text{and} \quad x &= (x-1)(x+1) \end{aligned}\right| \quad \dots\dots (4)$$

respectively It is remarkable that each of these equations reduces to the golden equation (1). Hence the answer to each question is the positive root

$$a = \left(1+\sqrt{5}\right)/2$$

of the golden equation.

The golden equation can also be written as $x = 1 + 1/x$. If we replace x by $1 + 1/x$ repeatedly on the right-hand side, we get the infinite continued fraction

$$1 + (1/1+)\ (1/1+)\ (1/1+) \quad \dots\dots (5)$$

Obviously, this continued fraction has the sum $a = \left(1 + \sqrt{5}\right)/2$. On the other hand, we can write $x = \sqrt{(1+x)}$ and replace x by $\sqrt{(1 + x)}$ repeatedly on the right-hand-side. Then we find that

$$x=\sqrt{1+x} = \sqrt{1+\sqrt{(1+x)}} = \sqrt{1+\sqrt{1+(1+x)}} = \dots\dots (6)$$

In the plane rectangular coordinate system, the curves $y = x^2$ and $y = x+1$ intersect at two points $A = (a, a+1)$ and $B = (b, b + 1)$, where a, b are given by (2) It should be noted that the line-segment $\overline{AB}$ has length $\sqrt{10}$, which is a rough approximation for π This line-segment meets the y-axis at the point $C = (0, 1)$. The ordinate of C is the geometric-mean of the ordinates of A and B.

If we repeatedly multiply both sides of the golden equation (1) by x, and replace x^2 by $x + 1$ whenever it occurs, we get the equation $x^n = a_n x + b_n$ where

$$\left.\begin{aligned} a_1 &= a_2 = 1 \\ a_n &= a_{n-1} + a_{n-2} \\ \text{and} \quad b_n &= a_{n-1} \end{aligned}\right| \quad \dots (7)$$

This shows that the coefficients a_n are precisely the Fibonacci-numbers, named after their inventor Leonardo (Pisano) Fibonacci, of Pisa (Italy), who lived in the 13th century. These numbers have wide applications in biology, botany, agriculture, non-linear programming, optimisation methods and so on.

The first ten Fibonacci-numbers are

1, 1, 2, 3, 5, 8, 13, 21, 34, 55.

There is an interesting "origin", cited for these numbers. It is assumed that a rabbit/cow can produce one young per month/year, starting from the second completed month/year (of its life) onwards. If there is only one rabbit/cow to start with, what is the number of rabbits/cows after n months/years? The answer is the nth Fibonacci-number a_n

If we write

$$P_n(x) = x^n - a_n x - a_{n-1}, \quad ..... (8)$$

where a_n is the nth Fibonacci-number, then we obtain

$$P_n(x) = x.p_{n-1}(x) + a_{n-1}.P_2(x) \quad ..... (9)$$

Repeated application of this formula yieds

$$P_n(x) = P_2(x).(a_{n-1} + x.a_{n-2} + x^2.a_{n-3} + \dots + x^{n-2}.a_1), \quad .... (10)$$

which can be put in the form

$$P_n(x) / (x^{n-1}.P_2(x)) = a_1/x + a_2/x^2 + \dots + a_{n-1}/x^{n-1} \quad .... (11)$$

For $x = \pm 1$, we get

$$a_1 + a_2 + \dots + a_n = a_{n+2} - 1 \quad ..... (12)$$

and

$$a_1 - a_2 + a_3 - a_4 + \dots + (-1)^{n-1} a_n = (-1)^{n-1} a_{n-1} + 1 \quad .... (13)$$

respectively.

After recalling that $a + b = 1$ and $ab = -1$, one can prove, by induction on n, that the nth Fibonacci-number is given by

$$a_n = (a^n - b^n)/(a - b) = (a^n - b^n)\sqrt{5} \quad ..... (14)$$

As a consequence, we have the following two infinite sums:

$$\sum(a_n / x^n) = x/x^2 - x - 1, \text{ if } |x| > a \quad ..... (15)$$

and

$$\sum(a_n x^n) = x(1 - x - x^2), \text{ if } |x| < 1/a \quad .... (16)$$

By actual division of $a^n - b^n$ by $a - b$, we obtain

$$a_n = \sum_{i=0}^{n-1} a^{n-r-1} b^i \quad .... (17)$$

Since $ab = -1$, we can eliminate either b or a. Then we get

$$a_n = \sum_{i=0}^{n-1} (-1)^4 a^{n-1-2i} \quad .... (18)$$

and

$$a_n = \sum_{r=0}^{n-1} (-1)^{n-r-1} b^{1-n+2r} \quad .. .. (19)$$

If, in formula (14), we write the actual values of a and b, and expand the powers by the binomial theorem, we get

$$a_n = 2^{1-n} ({}^nC_1 + {}^nC_3.5 + {}^nC_5\,5^2 + {}^nC_7.5^3 + \dots\dots) \quad ..... (20)$$

Here, the right-hand side is free from cumbersome irrational numbers.

If $p_n = a^n/a_n$, then, (14) implies that p_n approaches $\sqrt{5}$ as n tends to infinity. Since $\sum(1/a^n)$ converges to a, it follows from the limit-comparison test that $\sum(1/a_n)$ is also convergent. Since $p_1 \le p_n \le p_2$ for all n, we get $p_1/a^n \le 1/a_n \le p_2/a^n$ On summing over n, we get $p_1 a \le \sum(1/a_n) \le p_2 a$. That is to say,

$$a + 1 \le \sum(a/a_n) \le 2a + 1.$$

One notices that $(2a + 1) : (a + 1)$ is the golden ratio!

Oxidation-Reduction Reactions in Real Life Situations

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The logical starting point in the discussion of oxidation-reduction reactions is the atom, and the terms and conventions used by chemists in describing the phenomenon All atoms are electrically neutral even though they are comprised of charged, subatomic particles. The terms, oxidation states or oxidation number, have been developed to describe this "electrical state" of the atom. The oxidation state or oxidation number of an atom is simply defined as the sum of the negative and positive charges in an atom. Since every atom contains equal numbers of positive and negative charges, the oxidation state or oxidation number of any atom is always zero

Oxidation States/Oxidation Numbers

The rusting of metals, the process involved in photography, the way living systems produce and utilise energy, and the operation of a car battery, are but a few examples of a very common and important type of chemical reaction These chemical changes are all classified as 'electron-transfer' or oxidation-reduction reactions The term, oxidation, was derived from the observation that almost all elements reacted with oxygen to form compounds called oxides A typical example is the corrosion or rusting of iron as described by the chemical equation

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

Reduction, was the term originally used to describe the removal of oxygen from metal ores, which 'reduced' the metal ore to pure metal as shown·

$$2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4Fe$$

Based on the two examples above, oxidation can be defined very simply as, the "addition" of oxygen, and reduction, as the "removal" of oxygen But there is a lot more to "oxidation-reduction", as described in the following sections

Oxidation-Reduction Reactions: A Basic Model

Assigning all atoms an oxidation state of zero serves as an important reference point, as oxidation-reduction reactions always involve a change in the oxidation state of the atoms or ions involved. This change in oxidation state is due to the 'loss' or 'gain' of electrons The loss of electrons from an atom produces a positive oxidation state, while the gain of electrons results in negative oxidation states The changes that occur in the oxidation state of certain elements can be predicted quickly and accurately by the use of simple guidelines These guidelines are based on the behaviour of the Representative Elements: which can be divided into two classes; the metals and non-metals. All metal atoms are characterised by their tendency to be oxidised, losing one or more electrons, forming a positively charged ion, called a cation. During this oxidation reaction, the oxidation state of the metal always increases from zero to a positive number, such as '+1, +2, +3...', depending on the number of electrons lost. The number of electrons lost by these Representative metals and the charge of the cation formed are always equal to the Group number of the metal as summarised below:

Group Number	*Number of electrons lost*	*Charge of cation formed*
I	+1	1
II	+2	2
III	+3	3
IV	+4	4

The group numbers also correspond to the electrons that are found in the outermost energy levels of these atoms. These electrons are often called valence electrons. The oxidation state increases from zero to a positive number and is always numerically equal to the number of electrons lost The electrons lost by the metal are not destroyed but gained by the non-metal, which is said to be reduced. As the non-metal gains the electrons lost by the metal, it forms a negatively charged ion, called an anion. During this reduction reaction, the oxidation state of the non-metal always decreased from zero to a negative value (-1, -2, -3 ...) depending on the number of electrons gained. The number of electrons gained by any Representative Non-metal and the charge of the anion formed, can be predicted by use of the following guidelines.

Group Number	*Number of Electrons gained*	*Charge of anion formed*
IV	4	-4
V	3	-3
VI	2	-2
VII	1	-1
VIII	0	no tendency to form anions

Note that the GROUP VIII non-metals have no tendency to gain additional electrons, hence they are not reactive in terms of oxidation-reduction. This is one of the reasons why this family of elements was originally called the Inert Gases. The charge of anion formed is always numerically equal to the number of electrons gained. One important fact to remember in studying oxidation-reduction reactions is that the process of oxidation cannot occur without a corresponding reduction reaction. Oxidation must always be 'coupled' with reduction, and the electrons that are 'lost' by one substance must always be 'gained' by another as matter (such as electrons) cannot be destroyed or created. Hence, the terms 'lost, or gained', simply mean that the electrons are being transferred from one particle to another.

Everyday Examples of Oxidation-Reduction Reactions

Oxidation-reduction reactions have many far-reaching applications in our lives. Some of these applications are so common, that we take them for granted; others are not so obvious. The following are just a few examples of oxidation-reduction reactions.

Photosynthesis

An example of naturally-occurring biological oxidation-reduction reactions is the process of photosynthesis. It is a very complex process carried out by green plants, blue-green algae, and certain bacteria These organisms are able to harness the energy contained in sunlight, and via a series of oxidation-reduction reactions, produce oxygen and sugar, as well as other compounds which may be utilised for energy as well as the synthesis of other compounds The overall equation for the photosysnthetic process may be expressed as :

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 \text{ (glucose)} + 6O_2$$

The equation is the net result of two processes. One process involves the splitting of water. This process is really an oxidative process that requires light, and is often referred to as the *light reaction* This reaction may be written as

$$12\, H_2O \xrightarrow[\text{radiant energy}]{\text{(light or}} 6O_2 + 24H^+ + 24e^-$$

The oxidation of water is accompanied by a reduction reaction resulting in the formation of a compound, called nicotinamide adenine dinucleotide phosphate (NADPH). This reaction is illustrated below.

$$\underset{\text{(oxidised form)}}{NADP^+ + H_2O} \rightarrow \underset{\text{(reduced form)}}{NADPH} + \underset{\text{(oxygen)}}{H^+ + O}$$

This reaction is linked or coupled to yet another reaction resulting in the formation of a highly energetic compound, called adenosine triphosphate (ATP) As this reaction involves the addition of a phosphate group (labelled, as P_i to a compound called, adenosine diphosphate (ADP) during the *light reaction*, it is called *photophosphorylation*

$$ADP + P_i \rightarrow ATP$$

This of the *light reaction*, as a process by which organisms "capture and store" radiant energy as they produce oxygen gas This energy is stored in the form of chemical bonds of compounds such as NADPH and ATP The energy contained in both NADPH and ATP is then used to reduce carbon dioxide to glucose, a type of sugar ($C_6H_{12}O_6$) This reaction, shown below, does not require light, and it is often referred to as the *dark reaction*

$$6\, CO_2 + 24H^+ + 24\, e^- \rightarrow C_6H_{12}O_6 + 6H_2O$$

The chemical bonds present in glucose also contain a considerable amount of potential energy. This stored energy is released whenever glucose is catabolised (broken down) to drive cellular processes The carbon skeleton in glucose also serves as a source of carbon for the synthesis of other important biochemical compounds, such as lipids, amino acids, and nucleic acids In simplest terms, the process of photosynthesis can be viewed as one-half of the carbon cycle In this half, energy from the sun is captured and transformed into nutrients which can be utilised by higher organisms in the food chain The release of this energy during the metabolic re-conversion of glucose to water and carbon dioxide represents the second-half of the carbon cycle and it may be referred to as *catabolism* or *oxidative processes*.

Metabolism

Metabolism is a general term used to refer to all of the chemical reactions which occur in a living system. Metabolism can be divided into two parts: anabolism, or reactions involving the synthesis of compounds; and catabolism, or reactions involving the breakdown of compounds. In terms of oxidation reduction principles, anabolic reactions are primarily characterised by reduction reactions, such as the *dark reaction* in photosynthesis where carbon dioxide is reduced to form glucose. Catabolic reactions are primarily oxidation reactions. Although catabolism involves many separate reactions, an example of such a process can be described by the oxidation of glucose as shown below. Note that this equation is the reverse of the photosynthetic equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

Note also that, in this reaction, the carbon atoms in glucose are oxidised, undergoing an increase in oxidation state (each carbon loses 2 electrons) as they are converted to carbon dioxide. At the same time, each oxygen atoms is reduced by gaining 2 electrons when it is converted to water. Part of the energy is released as heat and the remainder is stored in the chemical bonds of "energetic" compounds such as ATP and NADH. Catabolic reactions can be divided into many different groups of reactions called, catabolic pathways. In these pathways (referred to as Glycolysis, the Citric Acid Cycle, and Electron Transport) the carbon atoms are slowly oxidised by a series of reactions which gradually modify the carbon skeleton of the compound as well as the oxidation state of carbon. Coupled to these reactions are other reversible oxidation-reduction reactions designed to capture the energy released and temporarily store it within the chemical bonds of compounds called adenoise triphosphate (ATP) and nicotamide dinucleotide (NADH). These compounds are then utilised to provide energy for driving the cellular machinery.

Corrosion

Crores of rupees are lost each year because of corrosion. Much of this loss is due to the corrosion of iron and steel, although many other metals may corrode as well. The problem with iron as well as many other metals is that the oxide formed by oxidation does not firmly adhere to the surface of the metal and flakes off easily causing 'pitting' Extensive pitting eventually causes structural weakness and disintegration of the metal. It should be noted, however, that certain metals, such as aluminium, form a very tough oxide coating which strongly bonds to the surface of the metal preventing the surface from further exposure to oxygen and corrosion. Corrosion occurs in the presence of moisture. For example, when iron is exposed to moist air, it reacts with oxygen to form rust. The amount of water complexed with the iron (III) oxide (ferric oxide) varies. The amount of water present also determines the colour of rust, which may vary from black to yellow to orange brown. The formation of rust is a very complex process which is thought to begin with the oxidation of iron to ferrous (iron '+2') ions

$Fe \rightarrow Fe^{+2} + 2e^-$

Both water and oxygen are required for the next sequence of reactions. The iron (+2) ions are further oxidised to form ferric ions (iron "+3") ions.

$Fe^{+2} \rightarrow Fe^{+3} + 1e^-$

The electrons provided from both oxidation steps are used to reduce oxygen as shown $O_2(g) + 2H_2O + 4e^- \rightarrow 4\ OH^-$

The ferric ions then combine with oxygen to form ferric oxide [iron (III) oxide] which is then hydrated with varying amounts of water The formation of rust can occur at some distance away from the actual pitting or erosion of iron This is possible because the electrons produced via the initial oxidation of iron can be conducted through the metal and the iron ions can diffuse through the water layer to another point on the metal surface where oxygen is available This process results in an electrochemical cell in which iron serves as the anode, oxygen gas as the cathode, and the aqueous solution of ions serving as a salt bridge'. The involvement of water accounts for the fact that rusting occurs much more rapidly in moist conditions as compared to a dry environment such as a desert Many other factors affect the rate of corrosion. For example, the presence of salt greatly enhances the rusting of metals. This is due to the fact that the dissolved salt increases the conductivity of the aqueous solution formed at the surface of the metal and enhances the rate of electrochemical corrosion. This is one reason why iron or steel tends to corrode much more quickly when exposed to salt or moist salty air near the ocean

Combustion of Fuels

The combustion or the burning of fuels is perhaps the most common and obvious example of oxidation and reduction Combustion is also that process which converts the potential energy of fuels into kinetic energy (heat and light) Most fuels (gasoline, diesel oil, propane, etc) are compounds comprised primarily of carbon and hydrogen These hydrocarbons represent an excellent source of potential energy which is released as heat during the combustion process. A common example is the oxidation of propane, the fuel used for gas ranges·

$$C_3H_8 + 5O_2 \rightarrow 3H_2O + CO_2 + \text{Heat}$$

As propane burns in air, its carbon atoms are oxidised when they combine with oxygen to form carbon dioxide In turn, molecular oxygen is reduced by the hydrogen atoms, forming water. The heat produced can be used directly, such as in the cooking of foods, or to cause the expansion of the gaseous products produced to perform mechanical work, such as in an internal combustion or steam engine. Many other substances besides hydrocarbons can be used as fuels. For example, the alcohols, such as methanol (CH_3OH) and ethanol (CH_3CH_2OH) are often used in racing cars Ethanol mixed with gasoline, called gasohol, is currently being explored as a substitute for gasoline. Among the simplest fuels is molecular hydrogen (H_2) which readily reacts with oxygen forming water as shown.

$2H_2 + O_2 \rightarrow 2H_2O$ + Energy

The simplicity and "nonpolluting" aspect of this oxidation-reduction reaction, the amount of energy produced, and the relative abundance of both hydrogen and oxygen in our environment, makes hydrogen a very attractive alternative fuel source. Research efforts are currently focussed on further developing the technology to broaden its use as a source of energy.

Bleaching Agents

Bleaching agents are compounds which are used to remove colour from substances such as textiles. In earlier times, textiles were bleached by exposure to the sun and air. Today, most commercial bleaches are oxidising agents, such as sodium hypochlorite (NaOCl) or hydrogen peroxide (H_2O_2) which are quite effective in 'decolourising' substances via oxidation. The action of these bleaches can be illustrated in the following simplified way: Recall that an oxidising agent is any substance which causes another substance to lose one or more electrons. The decolourising action of bleaches is due in part to their ability to remove these electrons which are activated by visible light to produce the various colours. The hypochlorite ion (OCl^-), found in many commercial preparations, is reduced to chloride ions and hydroxide ions forming a basic solution as it accepts electrons from the coloured material as shown·

$OCl^- + 2e^- + HOH \rightarrow Cl^- + 2OH^-$.

Bleaches are often combined with 'optical brighteners'. These compounds are quite different from bleaches. They are capable of absorbing wavelengths of ultraviolet light invisible to the human eye, and converting these wavelengths to blue or blue-green light. The blue or blue-green light is then reflected by the substance making the fabric appear much 'whiter and brighter' as more visible light is seen by the eye

Some Methods to Find Square and Square Root

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THE literature of early period shows that Indian philosophers had developed various concepts in different branches of mathematics They conceived the ideas and presented them in the form of interesting rhythmic verses and slokas Bhaskaracharya, one of the versatile mathematicians of the medieval period addressed the problems related to arithmetic, geometry, mensuration, etc. in his mathematical treatise *Lilavati* He used the unique dialogue method to present the problems and their solutions. While going through the *Lilavati* , the elegance of Sanskrit slokas containing abstract mathematical problems interwined with natural symbols and traces give the poetic and exhilarating experience. An attempt is being made here to discuss some of the slokas enunciated by Bhaskaracharya for finding the squares and square roots of numbers and to illustrate these methods through examples mentioning the steps involved in their calculation. Some other interesting methods to find square root are also presented, which may be useful to undertake some activities in this topic.

In *Lilavati* , four different methods are given to find the square The first method is similar to the procedure followed in modern mathematics but the other three methods are entirely different in terms of the algorithm involved The method to find the square given in sloka 11 of the topic *Atha Varge Karan Sutram* can be explained below:

(i) square the last digit of given number

(ii) double the last digit and multiply it with the rest of block of digits and add it to the value obtained from step (i) by putting it a place ahead

(iii) square the second digit from left.

(iv) double the second digit and multiply it with the rest of the digits and then add it to the value obtained from step (iii) by putting it a place ahead

(v) repeat the process upto the last digit

(vi) square the last digit.

(vii) add all the values by putting them one place ahead with the preceding value.

We illustrate below

Illustration 1 square of 4678

(i) $4^2 = 16$, $2 \times 4 = 8$, $8 \times 678 = 5424$; $16 + (5)424 = 21424$

(ii) $6^2 = 36$, $2 \times 6 = 12$, $12 \times 78 = 936$; $36 + (9)36 = 4536$

(iii) $7^2 = 49$, $2 \times 7 = 14$, $14 \times 8 = 112$, $49 + (11)2 = 602$

(iv) $8^2 = 64$

So square of 4678 is

```
2 1 4 2 4
    4 5 3 6
        6 0 2
            6 4
---------------
2 1 8 8 3 6 8 4
```

Illustration 2 square of 67583401

(i) $6^2 = 36$; $2 \times 6 = 12$;
$12 \times 7583401 = 91000812$;
$36 + (9)1000812 = 451000812$

(ii) $7^2 = 49$; $2 \times 7 = 14$;
$14 \times 583401 = 8167614$;
$49 + (8)167614 = 57167614$

(iii) $5^2\ \ 25$; $2 \times 5 = 10$;
$10 \times 83401 = 834010$;
$25 + (8)34010 = 3334010$

(iv) $8^2 = 64$; $2 \times 8 = 16$;
$16 \times 33401 = 54416$;
$64 + (5)4416 = 694416$

(v) $3^2 = 9$, $2 \times 3 = 6$; $6 \times 401 = 2406$;
$9 + (2)406 = 11406$

(vi) $4^2 = 16$, $2 \times 4 = 8$; $8 \times 01 = 08$;
$16 + (0)08 = 1608$

(vii) $0^2 = 0$

(viii) $1^2 = 1$

so square of 67583401 is

```
4 5 1 0 0 0 8 1 2
    5 7 1 6 7 6 1 4
        3 3 3 4 0 1 0
            6 9 4 4 1 6
                1 1 4 0 6
                    1 6 0 8
                            0
                              1
-------------------------------
4 5 6 7 5 1 6 0 9 0 7 2 6 8 0 1
```

The second method given in the slokas 13 of *Lilavati* is suitable for the number of two digits in which the following algorithm is considered.

(i) divide the given number into two parts.

(ii) find the product of the divided parts

(iii) double the value obtained from step (ii).

(iv) square separately the divided parts.

(v) add the values obtained from step (iii) and step (iv).

We illustrate it below

Illustration 3 square of 93

(i) divide 93 into two parts, say 50 and 43.

(ii) product of divided parts $50 \times 43 = 2150$

(iii) double of 2150 is 4300.

(iv) square of both the divided parts, $50^2 = 2500$; $43^2 = 1849$.

(v) square of 93 is $4300 + 2500 + 1849 = 8649$.

Now we express this method of *Lilavati* in algebraic form. To find the square of z divide it into two parts x and y the formula

$$z^2 = (x+y)^2 = x^2 + y^2 + 2xy$$

explicitly combines the steps of this algorithm.

The third method given in *Lilavati* is an interesting way to find the square In this method we assume a number and then proceed further as per the following algorithm·

(i) take any assumed number, say y.

(ii) add y to the given number

(iii) subtract y from the given number

(iv) find the product of the values obtained from the steps (ii) and (iii)

(v) find the square of y.

(vi) add the values obtained from the steps (iv) and (v)

We illustrate it below

Illustration 4 square of 9673

Let assumed number be 327

(i) 9673 + 327 = 10000

(ii) 9673 − 327 = 9346

(iii) 9346 × 10000 = 93460000

(iv) find the square of assumed number 327

- (a) $3^2 = 9$; $2 \times 3 = 6$; $6 \times 27 = 162$, 9 + (1) 62 = 1062
- (b) $2^2 = 4$; $2 \times 2 = 4$, $4 \times 7 = 28$; 4 + (2) 8 = 68
- (c) $7^2 = 49$,

Square of 327 is 1062 + (6) 8 + (4) 9 = 106929

So square of 9673 is 93460000 + 106929 = 93566929

We express this method in algebraic form. To find square of x let us assume number be y Then the formula consisting all the steps of this algorithm is

$$x^2 = (x+y)\,(x-y) + y^2$$

Now we find squareroots by using the method given by Bhaskaracharya in sloka 14 which is explained in the following algorithm:

(i) see the places of digits in given number from right to left and put the mark | and – for odd and even places respectively.

(ii) see the digits from left to the digit of the last odd place.

(iii) see the digit (say x) whose square is nearest to the block of digits or digit obtained from step (ii) and get the difference.

(iv) double the value (x) and divide the value in such a way that suitable remainder is left because the square of the quotient is to be subtracted from it at next step

(v) subtract the square of the quotient as shown in illustration 5

(vi) find double of x and double of quotient and add these values by putting second value one place ahead and call it y.

(vii) divide the number by y as shown in illustration 5

(viii) repeat the process till we obtain remainder 0.

(ix) double the quotient obtained from the last step and add this value with y by putting it one place ahead and call it z.

(x) the required square root is half of z.

Illustration 5 square root of 974169

```
         9
         - | - | - |
9)       9 7 4 1 6 9
         8 1
18)      1 6 4 (8
         1 4 4
           2 0 1
             6 4
196)       1 3  7 6(7
           1 3  7 2
                  4 9
                  4 9
                   X
```

steps involved

(i) $9^2 = 81$; $2 \times 9 = 18$;

(ii) $8^2 = 64$; $2 \times 8 = 16$; $18 + (1)6 = 196$

(iii) $7^2 = 49$; $2 \times 7 = 14$; $196 + (1)4 = 1974$

(iv) $^1/_2(1974) = 987$

So square root of this number is 987

Illustration 6 square root of 9996004

```
9)     9
       -  |  -  |  -  |  -  |
       9  9  9  6  0  0  0  4
       8  1
18)    1  8  9 (9
       1  6  2
          2  7  6
             8  1
198)    1  9  5  0 (9
        1  7  8  2
           1  6  8  0
                 8  1
1998)   1  5  9  9  0 (8
          1  5  9  8  4
                     6  4
                     6  4
                      X
```

steps involved

(i) $9^2 = 81$; $2 \times 9 = 18$;

(ii) $9^2 = 81$; $2 \times 9 = 18$; $18 + (1)8 = 198$

(iii) $9^2 = 81$; $2 \times 9 = 18$; $198 + (1)8 = 1998$

(iv) $8^2 = 64$; $2 \times 8 = 16$; $1988 + (1)6 = 19996$

So square root is $^1/_2$ (19996) = 9998

Now we illustrate some other methods to find square roots which are taken from other ancient literature. To proceed further we follow the preliminaries given below.

(i) the digits in the square roots will be equal to the number of pairs formed by the digits from right to left

(ii) the last digit of the square root of the numbers ending with digit 1 will be either 1 or 9

(iii) the last digit of the square root of the numbers ending with digit 4 will be either 2 or 8

(iv) the last digit of the square root of the numbers ending with digit 5 will be 5.

(v) the last digit of the square root of the numbers ending with digit 6 will be either 4 or 6.

(vi) the last digit of the square root of the numbers ending with digit 9 will be either 3 or 7

(vii) the last digit of any perfect square number cannot be 2, 3, 7 and 8.

Illustration 7 square root of 58125376

(i) last digit of the given number is 6 so in its square root last digit should be either 4 or 6.

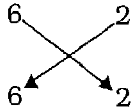
(ii) number of pairs in the given number are 4 so digits in its square root will be 4.

(iii) the last pair in the extreme left side is 58 and square of 7 is nearer to this value so we put 7 below the line and double of it in the left side

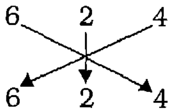
(iv) subtract square 7 from 58 and put 9 prefix to 1 in the second line as shown below.

(v) divide 91 by 14 and put quotient 6 below the line and remainder 7 prefit to 2.

(vi) subtract $\begin{array}{c}6\\6\downarrow\end{array}$ = 36 from 72 and divide 36 by 14 and put quotient 2 below the line and remainder 8 prefix to 5.

(vii) subtract 

= 24 from 85 and divide 61 by 14 and put quotient 4 below the line and remainder 5 prefix to 3.

(viii) subtract 

= 52 from 53 but 1 is not divisible by 14 so put 0 prefix to 7

14	58	1,	2	5	3	7	6
	49 · 9	7	8	5	0	0	
	7	6	2	4			

So square root is 7624.

Illustration 8 square root of 428135971041

(i) last digit of given number is 1 so its square root will have last digit either 1 or 9.

(ii) total pairs in given number are 6 so number of digits in its square root will be 6.

(iii) the extreme left pair of the digit is 42 for which square of 6 is nearer so, put 6 below the line and double of its in the left side.

(iv) subtract square of 6 from 42 and put remainder 6 prefix to 8 in the second line.

(v) divide 68 by 12 and put quotient 5 below the line and remainder 8 prefix to 1 as shown below product that can be measured colorimetrically.

NOx can be determined by chemiluminescence method also. In this method sample having NOx is reacted with O_3 to produce excited NO_2 molecule which emits radiation in the 600-3000 nm range.

$NO + O_3 \rightarrow NO_2 + O_2$

$NO_2^* \rightarrow NO_2 + h\nu$

A highly sensitive method for the determination of nitrogen dioxide (NO) in the air involves absorption of the nitrogen dioxide in a solution of sulfanilic acid that also contains an azo-dye forming N—(l-naphthyl) ethylene diamine dihydrochloride reagent. A stable pink colour is produced within 15 minutes. Concentrations of 0.005 to 5 ppm in nitrogen dioxide in the air can be measured using a spectrophotometer at 425 nm.

c) **Hydrocarbons**: Total hydrocarbons in the air can be determined using infrared spectrophotometry. The hydrocarbons are collected in a condensation trap immersed in liquid oxygen. The hydrocarbons absorb in the 3 to 4 nm region of the infrared spectrum using a 20m path length cell. They are expressed as ppm hexane and the instrument is calibrated using a standard hexane.

Aromatic hydrocarbons can be determined by GLC. In this technique the separation is carried out by exposing the injected sample to selective fractionating agents. The fractionating agent is usually held in an elongated column. With individual components of the sample being moved through the fractionating agent at different rates by a non-absorbable carrier gas such as helium. These separated individual components reach the detector which in most of the cases is a flame ionisation detector.

d) **Carbon monoxide**. The standard method for the analysis of CO is non-dispersive infrared spectrometry. It is based on the principle that CO strongly absorbs IR radiation at some wavelengths.

10 ppm or even lower concentrations of CO in air can be measured by gas chromatography with a flame ionisation detector The estimation is carried out by reducing the sample catalytically by hydrogen over a Nickel Catalyst at about 360°C and then measuring with a flame ionisation detector.

$$CO + 3H_2 \xrightarrow[Ni]{360'} CH_4 + H_2O$$

e) **Particulate matter**: Visible or electron microscopy is the best technique for characterisation of particles in air. Silicates and polycyclic aromatics can be determined by chromatography and fluorides can be determined by potentiometry. Atomic absorption spectrophotometry is most suitable technique for the determination of elements, e.g. As, Se, Cd, Cr, Cu, Fe, Mn, Pb etc. present in air.

Analysis of Water Pollutants

The water pollution is caused by industries such as petroleum, iron and steel, pulp and paper, coal, chemical and food. Besides industries, public and private sewages, land runoff erosion and mine wastes also lead to water pollution. The pollutants in the water lead to bad taste of drinking water, offensive odours from lakes, rivers and ocean beaches; growth of aquatic weeds in water bodies; decrease in number of fish; and oil and grease floating on water surfaces.

For the analysis of water pollution, samples are collected from outlets, at different points in pipe systems, from surface of rivers and lake waters, and at different depths The most important consideration is that the frequency and duration of sampling be sufficient to obtain a representative and reproducible sample. In some cases composite samples may be used in which individual samples taken at frequent intervals are combined.

Samples should be analysed as soon after collection as possible for maximum accuracy The certain constituents and physical values, immediate analysis in the field is necessary to obtain reliable results because the composition of the sample may change before it arrives at the laboratory. Included are pH and temperature and dissolved gases such as oxygen, hydrogen sulphide and carbon dioxide.

Analysis of some of the water pollutants is given below.

a) **Ammonia (NH_3):** Ammonia in water can be determined by spectrophotometric Nessler's method. The method is based on the reaction between NH_3 and HgI_4^{2-}, tetraiodo mercury (II) anion in alkaline solution:

$$NH_3 + 2HgI_4^{2-} + 3OH^- \rightarrow NH_2Hg_2IO + 7I^- + 2H_2O$$

The orange-brown reaction product tends to precipitate at higher concentrations while at lower concentration it is measured at 420 nm, spectrophotometrically

b) **Nitrate and nitrite (NO_3^-, NO_2^-):** Nitrate reacts with phenol disulphonic acid to form a nitro-derivative which in alkaline medium develops a yellow colour. Nitrate concentration can be determined at 410 nm spectrophotometrically

Determination of nitrite is based on diazotisation reactions. A reddish purple azo dye is produced at pH 2.0–2.5 by the coupling of diazotised sulphanilic acid with N-(1-naphthyl) ethylenediamine dihydrogen chloride. The concentration of nitrite can be determined by measuring the absorbance of the coloured solution at 425 nm spectrophotometrically.

Total nitrate and nitrite is determined by first reducing the nitrates and nitrites to NH_3 by Devarda's alloy (50%Cu, 45% Al, 5%Zn) in strong alkaline solution. The NH_3 is distilled into excess of standard acid and then estimated titrimetrically or spectrophotometrically.

c) **Chloride (Cl^-):** Chloride in water can be determined by titration with $AgNO_3$ solution using K_2CrO_4 as an indicator. The end point is indicated by the appearance of a permanent reddish tinge.

d) **Fluoride (F^-):** Ion selective electrode method is the most accurate method for the concentration of fluoride in water. This method is based on potentiometric measurements with a membrane electrode consisting of a single crystal of europium-doped lanthanum fluoride, LaF_3.

e) **Sulphate (SO_4^{2-}):** Sulphate can be estimated in water by its precipitation with $BaCl_2$. The filtered precipitate is ignited in crucible and weighed as $BaSO_4$.

f) **Phosphate (PO_4^{3-}):** The phosphate in water is boiled with ammonium molybdate which forms a complex heteropoly acid which gets reduced to a complex of blue colour in the presence of $SnCl_2$. The absorption of light by this blue colour can be measured at 690 nm spectrophotometrically to calculate the concentration of phosphate.

g) **Sulphide (S^{2-}):** The sulphide in the water is precipitated with $CdCl_2$ as CdS. In the acid medium with excess iodine the precipitate gets dissolved and the sulphide is oxidised to sulphur. The remaining iodine can be titrated against sodium thiosulphate using starch as an indicator.

h) **Total hardness (Ca^{2+} and Mg^{2+}):** The hardness of water in terms of Ca^{2+} and Mg^{2+} is determined by complexometric method with EDTA using Eriochrome Black-T as indicator.

i) **Be, Cd, Pb, Cr, Hg and Zn:** All these metals present in a solution can be measured using Atomic absorption spectrophotometric technique, selecting different wavelength for different metals.

j) **Chemical Oxygen Demand (COD):** The organic load of water can be measured in terms of COD. The method is based on the chemical oxidation of material in the presence of a catalyst by $Cr_2O_7^{2-}$ in 50% H_2SO_4.

$$3(CH_2O) + 16H^+ + 2Cr_2O_7^{2-} \rightarrow 4Cr^{3+} + 3CO_2 + 11H_2O$$

The amount of unreacted $Cr_2O_7^{2-}$ is then determined by titration with a standard Mohy's salt solution.

k) **Biochemical Oxygen Demand (BOD):** BOD is the amount of oxygen required for oxidation of organic matter by suitable aquatic organisms during a 5-day period at 20°C.

$$CH_2O \xrightarrow{\text{micro organisms}} CO_2 + H_2O$$

However, this is a semiquantitative method. The selection of micro-organisms is very important and the results ar-sfaaaaaaaaaaaaaaaae not obviously reproducible.

l) ***Escherichia coli (E. Coli)*:** Take sample of water and incubate in, cosive methylene blue agar medium at 37°C for 48 hours A pink to red colour with metallic surface sheet develops. The number of coliform colonies is counted and expressed as colony /100 ml sample.

m) **Total bacteria:** Incubate 0.1 ml of diluted sample in triptone-glucose agar medium at 35°C for 48 hours Count the number of colonies and express result in counts/100 ml of sample

Analysis of Soil Pollutants

The soil is also polluted by excess use of fertilisers, insecticides, pesticides, herbicides and irrigating water having different pollutants.

The soil sample is collected in polythene bags. The soil is collected from different depths. Sometimes a composite sample is also collected. The soil is sieved and ground and then converted into desired form for analysis. Analysis of the soil pollutants is given below:

a) **Chloride (Cl^-):** The titrimetric method with $AgNO_3$ is used for the determination of chloride in soil.

b) **Total phosphorus:** The organic phosphorus is converted into inorganic form after digestion with concentrated HNO_3. The total phosphorus is then estimated by calorimetric method employing ammonium molybdate and $SnCl_2$.

c) **Sulphate (SO_4^{2-}):** It is estimated in soil solution by precipitation with $BaCl_2$.

d) **Organic matter:** The organic matter present in the soil is digested with excess of potassium dichromate and H_2SO_4 and the residual unutilised dichromate is then titrated with ferrous ammonium sulphate

e) **Nitrogen (Organic and ammonium):** Nitrogen in the soil is present in the organic form, together with small quantities of ammonium and nitrate forms. Kjeldahl method is used for the measurement of organic and ammonium forms A separate method is used for estimation of nitrite form

In Kjeldahl method, soil is digested with concentrated H_2SO_4 in the presence of catalyst As the proper digestion takes place at higher temperature (360° - 450°C), sodium sulphate is added to raise the boiling point of sulphuric acid. Finally, after digestion, the nitrogen is converted into ammonium sulphate which can be determined after distillaton in alkaline condition.

Nitrate from the soil is extracted with copper sulphate and then is determined following the phenol disulphuric acid method as given in water pollution analysis.

f) **Metals:** Metals in the soil are determined by atomic absorption spectrophotometry (AAS), or polarography, spectrophotometry, neutron activation analysis, anodic stripping volumetry etc.

g) **Organic matter:** Walkey and Black method is followed for the estimation of organic matter in the soil. The dried soil (10 g) is taken in flask. In this add $K_2Cr_2O_7$ and conc. H_2SO_4 having Ag_2SO_4 dissolved in it. Mix the whole matrix. After 30 min when reaction is over, dilute with distilled water and add phosphoric acid and diphenyl amine indicator Titrate.

Analysis of Radioactive Pollutants

The radio nuclides released into the environment can be determined by counting the alpha and beta activities using G.M. Counter or scintillation counter. Alpha activity is due to the traces of transuranic elements while beta activity is due to radioactive alkaline earth metals (Sr-90) and rare earth metal(Ce-141).

Lecturing and Rote-learning Leading to Misconceptions in Physics

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IT IS A matter of common observation that through oral instruction, physics is presented as a set of formal procedures which most students cannot understand since they are not helped to reach the appropriate levels of thinking ability. Often, the college physics teachers do not seem to realise the dichotomy between the course content presentation and intellectual thinking. There is a common complaint that purely verbal indoctrination has hardly left any trace of understanding among physics students.

The lack of well-prepared school and higher education physics teachers is a worldwide phenomenon. The status problems are not often explicitly mentioned in the national reports on pre-service and in-service training of physics teachers. It is also being felt that there is a huge gap between the abstract lectures and actual teaching practice as it ought to be.

Due to this unhappy current situation of physics teaching both at school and higher education levels, some misconceptions among students physics learning have persisted for long Strangely enough, the literature on physics education does not report the remediation initiatives for removing the common misconceptions in physics.

Cognitively Researched Common Misconceptions

Some case studies of physics students and other investigations done by Diessa (3) are summarised as follows to describe the state of physics instruction leading to some common misconceptions among students.

College level physics students who are quiet familiar with the frameworks on Newtonian mechanics though get high score on standardised tests of physics knowledge but when probed or tested as their knowledge but when knowledge of physics in a context outside their textbook, they often fail miserably. A student from prestigious Massachusetts Institute of Technology (MIT), who was studying intensively found to know all the formulae taught in Freshman Physics. She could trot out the equation, $F = ma$, under appropriate textbook circumstances, she could faithfully recite Newton's laws of motion and she could employ the principles of vector summation when asked to do so with paper-pencil problem tests. But, she behaved as badly as a naive on a computer stimulated dynaturtle game for application of these laws. A good majority of students with education and training in physics do badly when posed with problems outside the strict confines of class, that is, outside what might be called the textbook context.

Classical physics teaches that objects move in a straight line when no external force acts on them. In an educational research, the students were shown a diagram of curvilinear tube on a horizontal surface and asked to predict the trajectory if an object that has been propelled through the tube and then is shot out from it. Nearly fifty per cent of students who could otherwise correctly state Newton's first law of motion indicated that the object will continue to move in a curvilinear fashion even after it has been released from the tube. As an explanation to this a good majority of students say that since an object that moves through the curved tube acquires a "force" or "momentum" that cause it to continue in curvilinear motion after it emerges from the tube. Many others explain that for a while the object will follow the curvilinear path and then its trajectory will eventually become straight due to dissipation of its force.

The secondary school science students were asked to designate the forces acting on a coin that is tossed straight up in the air and has reached the mid-point of its trajectory. Seventy percent of them answered it incorrectly. In general, they indicated two forces, a downward pointing one representing gravity and an upward pointing one representing "the original upward force of the hand".

More advanced students who had taken a course in the theory of relativity though were able to repeat back accurately the principal claims of relativity theory, according to which temporal and physical properties must be considered in the light of a particular frame of reference. But when they were asked to reason aloud to consider a problem of working of a light clock; the second involving synchronisation of distant clocks they fell back to a belief of an absolute space and timeframe - a firm Newtonian commitment to a mechanistic view of the world.

Middle school students receive instruction in the fact that the differences in seasons are not caused by the earth's physical distance from the sun but rather by the angle at which rays from the sun passes through earth's atmosphere due to the tilt of its axis But when the question is posed to them in an altered form, they reverted to an explanation in terms of physical distance.

The Need to Make a Shift in Physics Instruction

The cognitive researchers carrying out investigations in the area of teaching-learning process employed in physics say that the consistent misconceptions exhibited by well-trained science students are disconcerting. The above mentioned misconceptions of students are, in fact, the difficult spots of learning physics and need to be addressed properly by physics teachers.

According to Gardner (4), commonly the lessons in physics are taught and learned in such a way that they can be produced in certain debriefing context. Memorisation of facts; definitions and equations suffices; particularly when students know in advance the form of such debriefing will take place. Thus, there is a need to make a shift from the lecture method of teaching physics to that of concept-attainment and application methods.

The following didactic principles can be helpful for physics teachers to make a shift from much-used lecture model of teaching: (i) Reciting the stuff to be learned is no teaching; (ii) Storing something away in your memory is not learning, (iii) Ability to recall the memorised knowledge is not an evidence of understanding, (iv) To teach is to arrange learning environment and situations in which learner can discover knowledge generation, processes and structures for himself or herself; (v) To learn is to behave actively; (vi) Acts of learning manifest themselves as changes in self-directed, and individual behaviour disposition, (vii) Understanding is gaining insights into the reasons for the possible result of action.

A model of physics teaching based on the above stated principles can further the full development of human personality both that of the teacher and his or her students. An oft-quoted statement of Nachtigall (5) must certainly be taken by all physics educators. "We, as physicists in the universities, colleges and schools, have to look for the remedy in ourselves. We must have made the teaching of physics look unattractive or we have allow it to become so. Perhaps we have also made physics itself look unattractive in spite of our own enthusiasm or, worse still, because of our enthusiasm for it."

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The Role of Technology in Mathematics Teaching

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INFORMATION and communications technologies have become the important resources for teaching and learning mathematics. These technologies provide resources for enhancing, modifying, and connecting mathematics education to real-world applications. Resources that support this learning include the Internet, graphic calculators, simulation and spreadsheet software, real-time videoconferencing, and virtual reality simulations. Calculators, computers, and the World Wide Web are invaluable to students and teachers for effective teaching and learning. Technology can play a role in enhancing mathematical thinking, student and teacher discourse, and higher-order thinking by providing the tools for exploring and discovering mathematics. It allows students to visualise and experience mathematics in heretofore-impossible ways; and enables them to reflect on their activities and promotes reflective and cognitive processes in their problem solving that go below the surface and connect with the real world. Furthermore, technology allows students to undertake projects that connect with global communities, integrate mathematics with other subjects, and fit students' individual needs and interests.

The Development of the Role of Technology in Mathematics Teaching

- In India, during eighties, the use of pocket calculators became common. It can be described as the 'Algorithmic' period, the emphasis being on numerical aspects, with discrete methods and approximation emphasised and programming ability promoted.
- But the last decade is characterised by teaching with the help of software-applied packages and symbolic mathematical systems. Personal computers too are widely used these days especially in the prestigious institutions. The computer is seen as 'a teacher' of some basic definitions and results.
- The vision of the future, which is offered, involves the use of multimedia and computer networks, leading towards greater use of individualised teaching.

The greatest contribution of the present day technology is the development of computer and its use in all sectors of life. Computer-Assisted Instruction (CAI) and Computer-Assisted Learning (CAL) have emerged as the effective and efficient media of instruction and learning not only in the advanced countries but also even in most of the developing countries.

The use of following technologies in

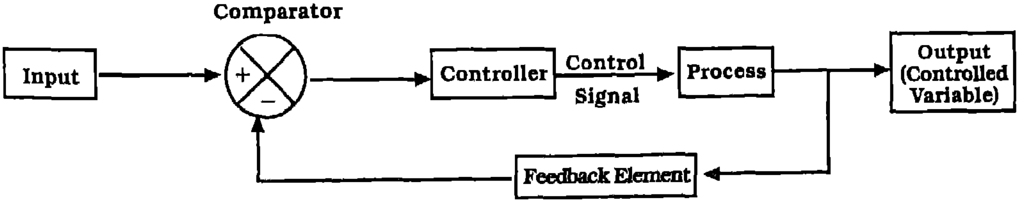
mathematics teaching will facilitate the teaching-learning process:

- The use of spreadsheets
- The use of function/graph plotting software
- The use of graphic calculators
- The use of integrating graphic calculators
- The use of Logo programming
- The use of the computer algebra system, DERIVE
- The use of Cabrie Geometry
- The use of hand-held calculators.

The use of **multimedia in the classroom** is the latest approach. This approach involved in the promotion of the use of group work. Particular features of the software are high quality video images of motion (on video disc and CD-ROM), a flexible mode of viewing the images, student choice of what to view and what graphs to consider, non-judgmental feedback from the computer and an emphasis on the process of graphical interpretation. The framework for evaluation is based on a view of learning as a fundamentally social activity, the role of the teacher as an active communicative participant and the computer as a medium for communication. Effective interaction was found to be dependent on engagement of the students in a cycle of observation, reflection, recording, discussion and feedback.

The following picture shows a diagrammatic representation of a feedback control system (Cleary, et. al.)

Formulating the problem is a fundamental part of human intellectual activity. The schools in the present millennium should have **IT-rich mathematics curriculum**. The need for curriculum reform in line with developments in the technology is essential. It has been accepted world-wide that mathematics instructional programmes should use technology to help all students understand mathematics and should prepare them to use mathematics in an increasingly technological world as it facilitates the transition from traditional mathematics to real-world problems



Feedback Loop

In the light of IT-rich mathematics curriculum, the role of computer and the teacher can be viewed as follows:

- **The role of computer** – This can be conceived as a tool, as a mediator of the teacher-student relationship and as a medium for communication
- **The role of the teacher** – This is seen to change as a result of using technology and is variously described as synthesiser, facilitator, modeller, co-explorer, promoter of exploration, instigator, helper, systematiser.

How the use of the technology changes the nature of the mathematics itself? — a question that baffles the ordinary teachers. Teachers' own subject knowledge and their confidence in their own mathematical abilities in order to work effectively in more open-ended ways are very essential. There is a dire need for teachers' training not only in a subject knowledge but also in the use of technology. Motivation results not only from the nature of the task but also more importantly from using the technology. The use of the technology improves or facilitates (not simply changes) the learning of certain concepts. Assessment practices might need to change as a result of using the technology. One will see the marked difference in the 'transfer' of learning when using technology and when using pencil and paper. Mathematics with technology will necessarily be better to mathematics with pencil and paper.

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Assessment in the Science Curriculum

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THERE are a plethora of procedures to use in assessing student achievement in science. The procedure used stresses a selected philosophy of assessment. The philosophy selected may be used on the federal, state, or local level of science teaching. There are inherent beliefs in choosing any one way of assessment In most cases, these approaches will be used on the state and local levels. At the present time, each state is wholeheartedly involved in the testing and measurement movement There are, however, other procedures to consider which also offer data and information on how well students are doing in science

The Standards Movement and High Stakes Testing

The standards movement is very strong in the United States presently. These standards are set by a select group of educators on the state level. How high to set these standards for selected grade levels in a state is indeed a problem. Setting standards for students to achieve in science are subjective. The problem to watch in setting these standards is to establish attainable, challenging objectives for students to achieve The standards can be set too high so few students can jump the hurdle. They may also be set too low so that everyone passes readily with little effort put forth by the learner. In 1998, when Massachusetts test results were reported for the first time, 81 per cent of the ninth graders were either failing or in need of improvement on the English/language arts exam, 71 per cent of 8th graders faired just as poorly on the science/technology tests, and 74 per cent of 10th graders got failing or needed improvement ratings on the math test In Virginia, 98 per cent of schools were given failing marks on the first Virginia Standards of Learning Test in 1998 But on some of the tests, such as 8th grade science, as many as 71 per cent of individuals were earning passing grades that year. Last year, the percentage of individual students passing the tests ranged from 39 per cent in 10th grade US history to 85 per cent in writing (Viadero, January 11, 2001).

The above data indicate that standards can be set excessively high if 81 per cent failed or needed improvement in English/language arts, 71% faired as poorly in science/technology, and 74 per cent of 10th graders received failing or needed improvement ratings. The state of Virginia really topped it off with complex state standards for students to achieve with 95 per cent receiving failing grades!

A further problem involves writing related test items to measure student achievement. There are states which have been weak in aligning test items with the state standards. Some states, too, do not test on all the state standards. To truly be valid, the state mandated test must cover what is contained in the state standards, or objectives, for students to attain.

State standards or objectives need to be available to all teachers to use in teaching. Teachers have a better idea then of what should be taught. State tests need to cover what is contained in the standards so that validity in testing is in evidence. Science teachers need to have some security in that what is taught will be covered on the test so that validity may be stressed. This is especially important with high stakes testing. If a high school senior does not pass a state mandated exit test, the consequences may be grave. What is a student to do without a diploma at the workplace, let alone not being able to go on to higher education, if abilities and interests should permit. There are states which permit a student to take the test over again, as many as three times. If a student cannot possess the state exit test, he/she may complete GED requirements. But taking many tests requires many routes and discouragement may indeed set in.

States need to be very careful in the following areas:

1. standards and objectives are clearly written for teachers to use in teaching students. These need to be available on time for all teachers.
2. tests to measure student achievement in having achieved the standards need to possess high validity in covering what has been taught. Careful monitoring of the tests to see that they are valid is highly important. Tricky, vague multiple choice test items need to be eliminated/omitted or modified. Each multiple choice test item needs to be clearly written so that the test-taker knows what is wanted in terms of responses. Test items written need to follow standards determined by measurement specialists.
3. directions for administering the tests need to be on the understanding level of learners. The key or answers must be checked very religiously to have correct answers.
4. machine scoring of these tests by the involved state needs to be monitored so that computer glitches do not occur. These have occurred and computers are not perfect.
5. hopefully, the teacher can use the available results for diagnosis and remediation in guiding students to do well on these tests.

There are selected assumptions which state mandated standards and tests operate on, including the following:

1. these are the "eureka" or "I have found it" in terms of what students should truly learn.
2. all teachers should emphasise these objectives in teaching students, regardless of the latter's abilities, talents and interests. Individual differences among learners do not matter: "one size fits all."

3. multiple choice test items can truly ascertain student achievement. Multiple Intelligences Theory (Gardner, 1993) emphasises that individuals possess unique abilities in learning, working, and showing achievement; verbal intelligence as shown in reading of test items is one among the eight intelligences.
4. with good teaching, the gaps in achievement between the rich and the poor can be eliminated. Socioeconomic levels then do not enter into how well a student can achieve
5. teachers who fail to teach well will tend to have students with low test scores. Paying teachers for higher students performance may end the vicious cycle of low student achievement.
6. competition among students can foster higher achievement with revealed test scores. These scores will differentiate the sheep from the goats and indicate which ones truly try to achieve at higher levels
7. report cards, published in the media, will indicate which schools are doing well and which, perhaps, should even be closed due to poor student achievement. The low achieving schools will feel pressure to do better and reach acceptable test score results.
8. to reach state standards is a motivator for all students. Increased competition is like the marketplace of goods and services sold. Students who do not do well on tests should have the option of selecting other schools to attend, including the use of vouchers. School selection then is like choosing from among the many goods and services to buy; those schools which survive and are chosen for attendance are the better institutions of learning.
9. punishments can be meted out to teachers for failing to have students achieve at a higher level. Merit pay should be given only for improved student performance; vouchers for students to opt out of low performing schools regardless of low socioeconomic levels; as well as school bankruptcy laws.
10. states do not need to release test questions to interested groups, even if a high percentage of students fail a state test, such as in Arisona when 12 per cent of highschol sophomores failed a mandated test.

The *Arizona Republic* newspaper had to sue to obtain release of some of the state mandated test questions (Education Week, February 7, 2001).

The Portfolio Movement and Science Achievement Assessment

Portfolios are a rather recent assessment instrument added to the arsenal of student evaluation. Portfolios do not emphasise measurement methods to ascertain learners achievement, but rather use the everyday classroom products and process to ascertain how well a student is achieving. Thus, the following are considered as inherent facets of a student's portfolio:

1. written work of the student in science, such as reports, outlines, summaries, book reports, and journal entries.
2. art products relating directly to a science unit encountered, such as a mural, pencil sketching, water colouring, and construction items. If these items are too large for a portfolio, they may be added in snapshot form.
3. cassette recordings of oral reports and oral reading, committee work, as well as a video-tape of students involved in doing science experiments and demonstrations.

The portfolio does not stress external examiners, such as test writers to determine what students are to learn and do. Rather, these decisions are made inside the classroom. The student with teacher guidance decides upon which entries to place inside a portfolio. Relevant items need to be inherent, so that the portfolio does not become excessively voluminous. When parents observe the contents of a science portfolio, they can evaluate how well their offspring is achieving in science. Teachers may evaluate each other's portfolios as well as their own. Evaluations here may be compared between the two teachers' appraisals for interater reliability. There are definite assumptions made by portfolio advocates to ascertain student achievement in science. Among others, these include the following:

1. it is the student's daily work in science which is important, not a single test score.
2. the observer of the science portfolio may notice progress of the individual student by viewing sequential entries.
3. daily work of students in science provides evidence of product and process achievement, not responses to multiple choice test items.

Hands on Approaches in Science Assessment

Since the major goal of science instruction is a hands-on approach in teaching students, the methods of learning science should be central in the assessment process. Multiple choice test items will not measure student achievement in performing science experiments and demonstrations In the science laboratory, scientists do perform many experiments and demonstrations. Thus, it behooves the assessment process to consider these hands-on approaches in learning. How might these learning experiences be assessed? A set of three to four assessors may observe students in a group setting. A five-point scale may be used to assess different criteria in how effective students are in using the methods of science in completing tasks to achieve objectives. Each of the following, as an example, may then be rated by observers on a five-point scale:

1. identification of a problem area. The problem needs to be relevant in an ongoing learning opportunity. Thus, in context, students are to identify a problem. The problem needs to be

adequately delimited so that solutions may be found. A problem may well arise directly within a science experiment or demonstration.

2. next, information needs to be gathered in attempting to find an answer to the problem. Deliberation and thought should go into the information gathering stage. Critical and creative thinking are needed.
3 the result should be a hypothesis directly related to the problem. Hypotheses are tentative and not absolute. The tentative solution (hypothesis) then needs to be tested, through using a variety of reference sources, including a science experiment/demonstration
4 the hypothesis may stand as is or be revised, based on evidence. Creative thinking is necessary to evaluate the adequacy of the hypothesis. Logical thought, also, is basic to reasoning about hypothesis adequacy.
5 additional problems and questions may arise during the entire learning opportunity, desired in the flexible steps listed above.

To perform science experiments and demonstrations, the teacher needs adequate materials, either brought from home or commercially purchased. The latter certainly is highly recommended. Each school should have ample science equipment at the teacher's finger tips without having to borrow from other teachers. Additional materials of instruction needed in problem solving include the following:

1. science and general encyclopaedias, multiple series of up-to-date basal textbooks and workbooks, library books on a variety of topics in science and on diverse reading levels, laboratory manuals, and related printed materials.
2. cassettes, video-tapes, software for tutorial and simulation experiences, CDs, Internet, and World Wide Web.
3. art supplies, water colours, coloured pencils, construction paper, and other media to be used.

Assumptions pertaining to using a hands-on approach in science teaching include the following·

1. students are using methods and materials emphasised by scientists in a laboratory setting.
2. students are actively involved in identifying and solving problems in the science curriculum. External examiners are not determining the objectives, learning opportunities, and assessment procedures.
3. students may transfer methods and procedures used by scientists in a laboratory approach to their own individual classrooms as well as in the societal arenas.

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Facilitating Learning Physics among Higher Secondary Students

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Our teaching-learning process in classrooms is mainly focussed on the formation of concepts with an understanding of theories and principles of curriculum. The National Policy on Education (1986) emphasised the need for change in the teachers' outlook of teaching and dissemination of instruction. It also emphasised the necessity of identifying the problems of the learners and for planning the learning activities using innovative methods for effective dissemination of instruction.

Many factors influence students learning. Cognitive factors like intelligence, creativity and memory, affective factors like motivation, social factors like maturation, age, sex, social background and study habits are of great relevance to learning (J.K. Pillai, 1998). Good study habits are increasingly important as the child grows older and takes responsibility for his own learning Receiving all the information, instructed in the classroom, depends upon the readiness of the learner. It can be determined by emotions, social background, peers, family situation etc. Further, the proper processing in students' mind depends upon the amount of information received, quality of processing, ways of processing and the storage capacity of the information processing system.

Hence the need for student counselling is imminent. The role of counselling is to sensitise the individual to his potential to determine what he would like to be as an individual It helps the pupils to understand and classify their views of their life space, and to learn to reach their self-determined goals through meaningful, well-informed choices and through resolution of problems of an emotional or interpersonal nature. If pupils are denied the opportunity of assimilating the reality of what has happened to them, they may experience acute stress subsequent to the event.

Counselling on Family Therapy

The goal of the family counselling is not merely to remove some symptoms but to create a new way of living. This involves helping people to express emotion. Nathan Ackerman (1958) places enormous emphasis on this approach and the relationship between the individual, family and other social systems is considered to be important in the 'ecology of human development'. He introduced the concept of interlocking pathologies, whereby the problems of one family member are tied up with interactions with other members. Murray Bowen (1958) introduced the concept of fusion. Fusion means that various family members cannot act independently of one another and are stuck together forming a vogue, amorphous mess. These two concepts are involved in family counselling.

Counselling on Peer Influences

Healthy peer relationship is a necessity for human development. Constructive relationships stimulate learning, the internalising of values, attitudes and competencies and effective socialisation. Interaction with peers provides support, opportunities and models for pro-social behaviour. If children perceive their peers as admiring pro-social actions, such as honesty, altruism, co-operation and respect for individuals, they will tend to engage in such behaviour. If adolescents perceive of their friends as disapproving of such actions, they will tend not to engage in them. The widescale rejection of a child by peers, furthermore, tends to promote antisocial actions by the child, such as aggressiveness, disruptiveness, and other negatively perceived behaviour.

One of the major differences between the successful and less successful students of similar ability is the use of strategies to learning. The quality of our learning outcomes is determined by the quality of our thoughts (Schmeek, 1988). Thinking involves the quality of information processing which is activated by memory strategies.

The Role of Strategies

Careful observation of teachers in classrooms reveals that they provide very little instruction in "how to memorise" (Moley et al., 1986). So teachers should provide more direct instruction in these skills. Efficient routinised memory strategies help the students to learn the basic knowledge in a curriculum area and free the students to concentrate on more complex behaviours. Use of strategy is one of the most important processes hypothesised by the Information Processing Approach. Strategies are conscious, cognitive or behavioural activities that are used to enhance mental performance. The main purpose of a strategy is to decrease the load on the child's information processing system by increasing the efficiency of each process, thus, freeing up space for other tasks.

Student may use both an imagery store and a verbal store for encoding input. The imagery system works better in processing concrete and spatial information; the verbal system works better in processing abstract and sequential information. The two systems are interconnected. When we can attach verbal material to pictorial images and pictorial images to verbal labels, we can usually retrieve information better (Bower, 1970a). Because most school learning is verbal; students should learn how to associate imagery with verbal material.

Levin and his colleagues have shown how the keyword method can improve learning. Techniques to help us remember are called mnemonics devices They–(a) are constantly effective, (b) show large effects (c) are usable in many different curriculum areas and (d) take little time to teach. Levin (1981) and Bellzza (1981) have similar comments to make about memories in education.

On the above criteria, ten low-scoring students were identified to form a group. They were asked to express their difficulties in learning. On the basis of students' statements, the factors related to retrieval failure can be assumed with family-related factors, peer-related factors, school-related factors, class room instruction related factors. To over come all these difficulties, a multi-dimensional approach is needed. The investigator attempt to give a package of counselling sessions to parents and students and suitable strategy training programmes to students.

Need and Significance of the Study

The National Policy on Education (1986) emphasised the need for change in the teachers' outlook of teaching and dissemination of instruction. Teaching should be learner-centred. It also emphasised the necessity to identify the problems of the learners and to plan the learning activities before teaching and using innovative methods for effective dissemination of instruction.

Receiving the information instructed in the classroom does not depend upon the amount of information given but the readiness of the learner. It can be determined by emotions, peer influences and family background and similar other factors.

The family also, at times, instead of being breeding centre for love and affection, may be the centre for creating tensions, conflicts and frustrations. There may be sibling rivalry, parental rejection, and unhealthy family atmosphere. Many other social factors may create a sense of insecurity in the student Economic stress, taboos, restrictions, competition, rivalry are a few stumbling blocks in a student's achievement. These things may affect the behaviour of the student in school. Further, it leads to emotions and frustrations. Conducting counselling sessions can help student to modify emotions.

Research reports in India indicate that students seek help of parents and elders to solve their educational problems. These indicate that there is a great need for counselling in schools in India.

Our aim of classroom instruction is to optimise the learning outcome. The proper processing in students' memory depends upon the amount of information received, quality of processing and the ways of processing. Using memory strategies is to decrease the load on the child's information processing system by increasing the efficiency of each process, thus, freeing up space for other tasks.

Hence, the investigator should attempt to give a package of counselling sessions to parents and students and suitable strategy training programmes to students.

Scope of the Study

The aim of this study is to help the students to overcome their difficulties and improve their information processing towards the enhancement of learning outcome.

This study is likely to help on the use of strategies to enhance the students' information processing and the counselling sessions to parents and students, which relieve the emotions of the students

Applications of this remedial package will enhance the achievement of students in physics learning and, in addition, the students' overall performance should increase considerably.

Objectives

(i) To identify the difficulties perceived by the students (low achievements) in learning of physics

(ii) To develop a remedial package to overcome the difficulties

(iii) To find out the effect of remedial package on enhancing their achievements in physics.

Hypothesis

Strategy training and counselling sessions' packages significantly improve the achievement of students in physics at the higher secondary stage.

Tool for Study

(i) Tool for identification of problem.

The students were asked to express their difficulties in classroom learning. They were instructed to be free to express their difficulties, the type and extent of difficulties. They were assured the confidentiality of their statements

(ii) Achievement tests were used for the purpose of pre-test and post-test.

This was a generalised Test of Achievement in Physics for higher secondary school pupils of Class XII. It was constructed and validated by the investigator. The test included questions of objective type, short answer type and some para/essay questions also.

Reliability of the Tool

The reliability of the test was found by parallel form method and it was found to be 0 86 which was significant.

Location and Sample

The present investigation was carried out in Govt. Hr. Sec. School, Ariyakudi, Sivaganga district in Tamil Nadu Ten students (low achievers) selected from Class XII of the school formed the sample of the present study Achievement marks secured by the students in physics in the quarterly examination were taken as a basis for selection.

Methodology of the Study

In this study, all the ten students faced different problems Hence, the investigator decided to choose case study method. All the ten cases were dealt with individually.

Conducting the Experiment

In this study, ten low-scoring students in physics in quarterly examination were identified and formed a group in Govt. Hr Sec. School, Ariyakudi. They were asked to express their difficulties in classroom learning in a separate sheet. They were instructed to be free to express number of difficulties,-type and amount of difficulties. They were assured the confidentiality of their statements. As a whole, 45 problems were expressed. Most of the students expressed that they understand clearly in the classroom but cannot recall it the other day or even on the same day. Their attribute for the main cause of the retrieval failure is poor retention. The process of retention involves encoding of the observed behaviour in long-term memory. Some needed strategy training to enhance the level of information processing in their memory; some needed family therapy counselling to the parents; some other needed peer influence counselling to the students and a few related to health problems.

On the basis of students' statements, the factors related to their difficulties were Grouped and tabulated (Table 1) as home-related factors (over work, separate study room, watching TV by other members, frequent visits of relatives and friends), school-related factors (exam fear, over load, difficulty in textbook words), classroom instruction related factors (retrieval failure), peer-related factors (noise, bullying, discouraging, unnecessary talking) and other factors (eye problem, poor memory, taking medicine) (Table 2). Some statements were repeated by other students also (Table 3).

It was found that eight students expressed retrieval failure. Hence, all the eight students were formed as a group and were given training on memory strategies. It included rehearsing, keyword method, imagery and chunking for the period of 4 weeks. In addition, they were dealt with individually for their other problems. Each student had more than one problem. Hence, each student was dealt with individually and the suitable counselling sessions were conducted separately to the parents and students (Table 4).

1. Retrieval failure

Eight students expressed their difficulties to their retrieval failure. The lessons were understood clearly in classroom but they could not recall them on the next day or two days later. Some pupils expressed their difficulty even on the same day. They were not able to retrieve from the memory.

This difficulty occurred due to the lapses in processing information in students' mind. Particularly, the chunking, reconstructing, modifying processes were not doing well. Hence, the information was not encoded in long-term memory. To improve these processes, the investigator gave training on retrieving, keyword method, imagery and chunking strategies. Practising strategies decrease the load of the students' information processing system by increasing the efficiency of each process, thus, freeing up space for other tasks. Further, it lead to effective encoding process.

2. Poor memory

Six pupils expressed difficulties to their poor memory.

A suitable counselling was organised to students to know how to improve their memory by using strategies. And a separate counselling was organised to parents and students to understand the food concents for improving memory. They were made to understand the values of food and nutrition which play major role in the ability to learn and

TABLE 1

Problems perceived by the students while learning

Home related factors	*School related factors*	*Classroom related factors*	*Peer related factors*	*Other factors*
1 Over work	1. Exam fear	1. Retrieval failure	1 Noise	1 Eye problem
2 Need separate study room	2. Cognitive overload		2 Bullying	2. Poor memory
3. Watching T.V by other members	3 Difficulty in textbook words		3 Discouraging	3 Taking medine
4. Frequent visits of relative and friends			4. Unnecessary talking	
5 Inability to make study planning				

TABLE 3

Distribution of frequency of the problems perceived by the students while learning

Home related factors		*School related factors factors*		*Classroom related factors*		*Peer related factors*		*Other factors*	
Statement Number	*Frequency*	*Statement Number*	*Frequency*	*Statement Number*	*Frequency*	*Statement Number*	*Frequency*	*Statement Number*	*Frequency*
1	(4)	1	(1)	1	(8)	1	(2)	1	(1)
2	(1)	2	(2)			2	(2)	2	(6)
3	(1)	3	(1)			3	(1)	3	(2)
4	(1)					4	(1)	4	(1)
5	(1)								

Table (3) shows the frequency of the problem perceived by the students Statement numbers denoted the order of the problem in the group, frequency gives how many students perceived the same problem Example. 1(4) in home related factors It can be explained as the first problem in home related factors i e., over work was perceived by four students

TABLE 2

Distribution of priority of the problems as perceived by the students while learning

	Home related factors		*School related factors*		*Classroom related factors*		*Peer related factors*		*Other factors*	
Case No.	*Statement Priority Number*	*Statement Order in the group*	*Statement Priority Number*	*Statement Order in the group*	*Statement Priority Number*	*Statement Order in the group*	*Statement Priority Number*	*Statement Order in the group*	*Statement Priority Number*	*Statement Order in the group*
1.	2	(1)	–	–	1	(1)	3	(1) (2) (3)	4	(2)
2.	1	(1)	4	(1)	–	–	2,5	(1) (2) (4)	3	(2)
3.	–	–	2	(2)	3	(1)	–	–	1	(2)
4.	3	(1)	2	(3)	1	(1)	–	–	–	–
5.	–	–	–	–	1,3	(1)	–	–	2	(2)
6.	2	(1)	3	(2)	–	–	–	–	1,4	(2)(4)
7.	3	(5)	–	–	1	(1)	–	–	2	(3)
8.	2	(5)	–	–	1	(1)	–	–	2,3	(1) (2)
9.	2,3,4	(2)(3)(5)	–	–	1	(1)	–	–	–	–
10.	–	–	–	–	1	(1)	–	–	2	(3)

Table (2) shows the priority of the problem perceived by the students. Statement priority numbers denoted the order of priority of the problem given by the student; statement order in the group gives the identification of the problem within the group. Example. 2(1) in home related factors: It can be explained as the case one gave second priority to the problem which is number one in the home related factors i.e., over work.

TABLE 4
Programme of Remedial packages to the Students

S No.	Case No	Factor No.	Problems	Frequency	Remedial package
1	1,3,4,5 7, 8,9,10	III(1)	Retrieval failure	8	Strategies training (rehearsing, keyword method, imagery and chunking)
2	1,2,3, 5,6,8	V(2)	Poor memory	6	Counselling to parents and students to improve memory and awareness on food contents
3	1,2,4,6	I(1)	Over work	4	Counselling on fatigue avoidance to parents to understand the relationship between physical work and mental tiredness.
4	7,8	I(5)	Inability to study planning	2	Counselling on fear and anxiety avoidance to students to understand the time management
5	3,6	II(2)	Cognitive overload	2	Counselling on cognitive overload to students
6	1,2	IV(1)	Noise	2	Counselling on motivation to students to avoid noise
7	1,2	IV(2)	Bullying	2	Counselling on peer influences to students to understand to avoid antisocial activities
8	7,10	V(3)	Taking medicine	2	Counselling to students and parents to understand the effect of medicine and time management
9	9	I(2)	Need separate study room	1	Counselling on family therapy to students and parents to understand the adjustability
10	9	I(3)	Watching T V by other family members	1	Counselling on family therapy to students and parents to understand to develop adjustability
11	9	I(4)	Frequent visits of relatives and friends	1	Counselling on family therapy to parents and students to understand to give priority to studies
12	2	II(1)	Exam fear	1	Training on layout skills and note-making technique to reduce anxiety
13	4	II(3)	Difficulty to memorise text-book words	1	Training on note-making technique and keyword method strategies.
14	1	IV(3)	Discouraging	1	Counselling on peer influence to students to understand the value clause and understand time management.
15	2	IV(4)	Unnecessary talking	1	Counselling on motivation to students to understand time management.
16	8	V(1)	Eye problem	1	Counselling on eye protection and nutritious food to students and parents

memorise--accordingly the carbohydrates, proteins, fat, vitamins and minerals. Further, the role of proteins in the development of cognitive and affective systems and the role of fruits and vegetables and pulses are the major constituents of such nutritions. Pulses give proteins which in turn produce amino acids, which are highly responsible for enhancing neutral activities.

3. Overwork

Four pupils expressed their inability to concentrate on studies due to overwork at home.

A counselling session on fatigue avoidance was organised to parents. Overwork leads to fatigue. In practice, only those cases in which the organism at the personal level unable to meet the demand should be called fatigue. The tissue changes that reduce ability to function are more appropriately called impairment. When this impairment causes the organism at the personal level to become less able to function, the result is fatigue. Through counselling they were made to understand relation between the physical work and mental tiredness.

4. Study planning

Two pupils expressed their inability to plan the time to the subjects concerned.

This difficulty occurred due to fear and anxiety. Fear and anxiety are the states of arousal that result when an individual recognises a lack of power or capability to handle some threatening situation. A suitable counselling was given to the students to overcome the fear and anxiety. They were given training, on lay-out skills in note-making technique. Through the lay-out skills training, students were made to be aware of the overall lay-out of the subject concerned and time allotment according to the content load. Further, it leads to time planning to the subject concerned.

5. Cognitive overload

Two students expressed their liability to complete all the subjects within the time limit in regular study practice at home. They feel each and every subject is voluminous to comprehend.

A counselling session was organised to the students about the importance of combination of subjects and load on the subjects. Further, they were made to understand to plan time to complete all these subjects.

6. Noise

Two students complained that they were not able to concentrate on studies in leisure periods (times) due to the noise produced by peers.

A counselling on peer influence was organised to the students. They were made to know the healthy peer relationship as a necessity for human development. Lack of motivation is one of the reasons for those who are producing noise. They were motivated towards their aim through the counselling.

7. Bullying

Two students complained that they were not able to concentrate on studies in the leisure time due to bullying by peers

This problem was due to (disruptiveness) antisocial activities in peer influences. A peer influence counselling session was organised for the students. They were made to understand the psychological impact received by the individual due to bullying and to avoid bullying-like antisocial activities.

8. Taking medicine

Two students narrated that they were taking medicine for various physical illnesses. Hence, they got tired and could not spend more time to study

A suitable counselling session was organised for the students as well as parents to understand the effect of medicine. They were made to understand that most of the medicines have to be chemical contents, which induce sleepy feeling in them, hence a time planning is necessary to allot more time to study before taking medicine.

9. Separate study room

One student expressed his inability to concentrate on studies due to disturbances by other members of his family. He needs separate study room in his house.

A counselling session on family therapy was organised for him and for his parents to develop adjustability with other members of his family. He was made to know how he can get an arrangement to make himself feel convenient, disturbance-free study place in his house

10. Watching television by other members

One student expressed his inability to concentrate on studies because of the disturbances produced by other members of the family while watching television.

A counselling session on family therapy was organised for him and his parents to develop adjustability with other members of his family. They were made to know the concept of interlocking pathologies (Nathan Ackerman, 1958) whereby the problems of one family member are tied-up with interactions with other members. Further, the student was motivated to avoid eagerness for viewing television.

11. Relatives and friends

One student expressed his inability to concentrate on studies due to the frequent visits of relatives and friends

A counselling session of family therapy was organised for him and his parents. They were made to understand the interlocking pathologies in family therapy and to give importance to their son's studies The concept of Interlocking pathologies is the problem of one family member tied up with interaction with other members Further, the parents were made to know how to minimise the disturbances produced by the guests.

12. Exam fear

One student expressed his inability to recall all the answers in exam hall. But he recalled everything very easily, immediately while coming out of the hall.

A counselling session on exam anxiety was organised for him to reduce the exam anxiety. Due to the lapses on lay -out skills in note-making technique, the fear and anxiety were developed. He was given training on lay out skills in note-making technique Through this training the student can get an overall plan on the subject (marks allotment, easy to memorising content area, etc.), it leads to confidence to face the examination.

13. Difficulty to memorise textbook words

One student expressed his difficulty to memorise the textbook words.

A suitable counselling session was organised to the student to know the study skills and note-making technique. They were given training on strategies like mnemonics, keyword technique in order to help to memorise the technical words from the textbook.

14. Discouraging

One student complained that he could not concentrate on studies during the leisure time due to the discouraging words from his peers.

A counselling session on peer influence was organised for the student. He was made to understand prosocial and antisocial activities in peer influences. Further, he was made to understand the value clauses. The student was given training to overcome value clauses and to take right decision.

15. Unnecessary talking

One student expressed his inability to concentrate on studies during the leisure time due to unnecessary talking of his peers, who lack motivation.

A counselling session on peer influence was organised to the students. They were made to understand to give respect to others' feelings and the value of time. Further, they were motivated towards their studies.

16. Eye problem

One student expressed his inability to concentrate on studies due to eye problem.

A suitable counselling session was organised for the student as well as the parents. They were made to understand the importance of eyes and made aware of protecting eyes from dust, insects, other irritants, chemicals, etc. Further, they were given the awareness about the nutritious food to protect eyes and to maintain properly by consulting doctor periodically to test the vision of the eyes. The student was directed to meet the eye doctor for follow-up work.

Data analysis

After the completion of remedial package programme a post-test was conducted. Quarterly exam marks were considered as the pretest scores. The student's pretest and post-test scores were compared and analysed. Mean, standard deviation and Will Coxon's matched pair signed ranks test were used to find out the impact of the programme.

TABLE 5

Distribution of mean and standard deviation scores of the students in the pre-test

S. No	Marks
1	21
2	24
3	26
4	23
5	25
6	14
7	33
8	31
9	27
10	36

Mean = 26

S D = 5 98

Class average mark = 54

TABLE 6

Distribution of mean and standard deviation scores of the students in the post-test

S No.	Marks
1	56
2	65
3	68
4	50
5	59
6	49
7	69
8	47
9	46
10	70

Mean = 57.9

S.D. = 9.10

Overall class average marks = 55

From the table it was observed that the mean scores of the post-test was more than that of the pre-test.

The mean scores of the pre-test was less than that of the class average marks. The mean scores of the post-test was greater than that of the class average marks.

The calculated value $Z = 2.80$ is greater than the theoretical value 1.96 at 0.025 level of significance. There is significant mean difference between the pre-test and post-test scores of students

It is concluded that the students' achievement in physics had improved after implementing remedial package.

Major findings

1. The students' performance in post-test mean (57.9) is higher than that of the pre-test mean (26). This difference in achievement was due to the effect of the remedial package programme.
2. There is significant mean difference between the pre-test and post-test in the students' performance as the calculated value of Will Coxon's signed rank test (2.80) is greater than the critical value (1.96) at 0 025 level. Hence, the students' achievement has significantly increased in the post-test than that of the pre-test.

Educational implications of the study

On the basis of the above findings, the investigator suggests the following in order to improve or rather modify the current educational practice.

1. The counselling sessions and strategy training programmes are significant in facilitating physics

TABLE 7

Mean and standard deviation scores of students in the pre-test and post-test

Sl. No	Test	No. of Students	Mean	S.D.	Overall Mean	S.D.
1.	Pre test	10	26	5.98	54	8.6
2.	Post-test	10	57 9	9.10	55	7 9

TABLE 8

Will Coxon's signed ranks test on comparing the mean difference between the post-test and the pre-test scores

Sl. No.	*Experimental group*		Difference	Absolute rank of difference	R (+)	R (-)
	Pre test Scores X	Post-test Scores Y				
1	21	56	35	6.5	6.5	
2	24	65	41	9	9	
3	26	68	42	10	10	
4	23	50	27	3	3	
5	25	59	30	4	4	
6	14	49	35	6.5	6.5	
7	33	69	36	8	8	
8	31	47	16	1	1	
9	27	46	18	2	2	
10	36	70	34	5	5	

$\Sigma R^{(+)} = 55$ $\Sigma R^{(-)} = 0$

$\boxed{Z = 2.80}$

learning. Hence, these programmes could be implemented for improving the quality of learning.

2. The teachers should be given training on guidance and counselling programmes to enhance the students' performance and in facing conflicting situations.
3. The teachers should be given orientation programme to train students to apply memory strategies to enhance their achievement.

Conclusion

Teachers feel that the content of academic subject matter is the only knowledge to which they are responsible for teaching. Every student is endowed with abilities. Counselling helps an individual to discover his interest, potentialities and inherent interests for personal growth. The teachers should help the students to try to know their potentialities, abilities and needs. The teaches can help the students (through counselling) to modify emotions towards developing readiness to learning. One of the striking differences between achiever and low achiever of similar intellectual ability is the use of strategies to learn, think and problem solve. Some teachers teach skills and strategies for processing information, but rarely share with students' potentialities, strategies and weaknesses. It is the responsibility of the teachers to facilitate as a counsellor as well as thinking-learning facilitator in order to help students develop thinking skills. Researchers do agree that in addition to teaching specific content or real-world knowledge, teachers should share with students knowledge about how their minds work, and should extend help to solve their own problems. Thus, in addition to content knowledge, we need to provide students with an awareness of the factors that effect learning and the skills and strategies that would put them in control of their learning.

This study reveals that the counselling sessions and strategy training were effective in learning physics. Hence the educational planners, administrators and curriculum designers should give importance to arrange orientation programmes to teachers on counselling techniques. Further, the teachers should be given orientation programmes to train students to apply memory strategies. This will certainly develop the achievement level of the students.

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Concept Mapping in Science Teaching

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NATIONAL POLICY on Education (1986) has emphasised on 'Child Centred Education' which aims at conceptual mastery and functional applicability of the concepts taught in any discipline. Lack of conceptual clarity and inability to apply the theoretical knowledge and skill to practical situations amount to ineffective teaching-learning process. Piaget, Bruner (1971), Flavel (1976) and others have analysed the factors and conditions that function as impediments in effective teaching-learning process. The cognitive factors significantly affect the concept learning and concept attainment processes. Such cognitive ability as conceptualisation, reasoning, perception, thinking, memory, decision-making, risk-taking and the likes play crucial role in learning concepts and their attainments. Concept learning involves higher mental process like abstract thinking and high-order verbal learning. Different modes and methods are employed in concept learning process.

An efficient method of teaching concepts gives the learner the necessary skills to apply newly acquired concepts in different situations using different cognitive factors. Significant results have been obtained when the above-mentioned strategy is adopted by many researchers who formulated and tested for the development of scientific reasoning abilities in adolescents. Developing reasoning abilities bears a positive correlation with the level of concept attainment.

The mental health of the learner is an important aspect in learning of concepts. The teacher must create a conducive atmosphere in the class so that the learner's mind gets ready to imbibe the concepts easily. The difficult concepts must be introduced skillfully, because the manner in which a concept is presented counts a lot. Especially when it is an altogether new concept. For example, teaching the basic of Le Chatelier's Principle can be done as follows:

A pendulum in its steady state hangs vertical. But if an external force is applied to shift it to and then the force is released, the swing is found to shift to the left direction in the same magnitude to nullify the effect of the imposed change, so that the swing finally retains its equilibrium state. An introduction of such an analogous description develops an alertness and an interest in the pupil/learner to hear more about the cited example or demonstration. This sets the mind of the learner ready to accept more literature on the particular topic. This can be followed by directing the learner's attention to the subject matter, i.e. the principle states that "Whenever a change is imposed on a system in equilibrium, the equilibrium shifts in a direction so as to nullify the effect of the imposed change."

Simple language must be repeatedly used to make the concept clearly fixed to even a below average student. The importance of language in human learning is almost impossible to exaggerate Programmed instruction is perhaps a successful technique of learning science concepts A complex concept must be broken down into simple concepts and arranged sequentially to assist in conceptualisation. It is essential on the part of the teacher to have a clear idea of the individual's ability, with regard to his levels of cognition. This makes the teacher's job easy

Singh (1983) studied the memory symbolic representation and some other mental abilities in relation to achievement in Chemistry at graduation level. The investigation led to the fact that these mental abilities show a positive influence over achievement in Chemistry. A knowledge of these abilities would be successful to predict the success of a student in the study of Chemistry The work presented an instructional strategy based on the thesis that science concept learning involves cognitive accommodation of an initially held AF. The strategy consists of three phases·

1) Exposing afs
2) Creating conceptual conflicts and
3) Encouraging cognitive accommodation

Much of the tradition in the study of concept learning has been restricted to the study of Weige type problems with well-defined stimulus dimension.

Quintero (1983) carried out a study on conceptual understanding in solving two steps word problem with ratio. Krajcik et al (1988) developed a strategy for dynamic study of student's Concept and Problem Solving Strategies using Science Software. Siegler (1989) examined the domain general and domain specific knowledge work together to produce adaptive strategy choices. Stussy (1989) formulated and tested a model for the development of Scientific Reasoning Abilities in adolescents. Hartey et al. (1985) determined the relationship between pupils Science Concept Structure Interrelatedness Competence (SIC) and ten predictor variables, of which six comprised cognitive cluster and four made up of effective set. Significant positive correlations were found between con SIC and Science Achievement.

Studies that are referred to concept learning have doubtful generalisability and applicability to human concept learning in natural habitat These studies emphasise the role of the teacher and not that of the learner Instruction is not only exhibiting information, but it is transmission to and reception by the learner. Furthermore, the question is not that of whether the experimenter can analyse the information content of the tasks, but to instruct the learner to do the task. The main function is to motivate the teacher and to activate the learner to analyse in a correct way and act accordingly. If the information content of the task is easily analysed by the learner, then learner may well use different learning strategies as compared to the information content which is not open. Differences in the information communicated by instructional methods need not be measured to compare methods. Differences among instructional methods as measured by what the learner can do, are the appropriate measure of instructional effectiveness.

Concept Mapping is a technique to help students to organise their information and understanding of a topic in a conventional scientific way. It is a practical and useful classroom tool and has a variety of uses in education. The various factors attributing to concept, their relation to the concept, the positive and negative aspects of a concept are depicted in a concept map. It is a precise form in which a concept can easily be understood by the learner. The "Concept Mapping", which is prepared on the Ausubelian learning theory, has a variety of uses in science. Concept mapping is a technique for representing knowledge in graphs. Knowledge graphs are methods of concept network which consists of nodes (points or vertices) and links. Nodes represent concept and link represents the relationship between concepts. Concept mapping is a tool for defining and refining ideas developed by D. Novak (1960) at Cornell University. D. Novak concluded that "Meaningful learning involves assimilations of new concept and propositions into existing cognitive structure. Concept Mapping, is in some sense, related to knowledge management. Concept Mapping is a diagram that shows the organisation of ideas and relationship among concepts in a particular sub-area

The Concept Mapping is an organised hierarchy of the concepts of knowledge which are connected with lines or chains which explicitly explain the relationship among the concepts.

The process of preparing a concept map comprises four major steps: (1) Identify the Key Concept of the map (2) Entering in subordinate concepts in similar nodes (3) Identification of the relationship between each subordinate concepts and Key Concepts by creating and labelling a link (line) between the two and (4) Repeating this process as information is added to the map.

In science, Concept Maps can be used to help students to construct conventional scientific meanings. Figures 1 and 2 present, at a glance, how chemistry can be taught through concept mapping in an effective and efficient manner.

Concept Maps improve the achievement of students and increase the students' curiosity and learning ability. The student finds the learning process very easy and shows a marked improvement in recalling capacity. This is because, concept maps help the learner to improve association between different aspects of the concept. Once the learner develops clear concepts, their reasoning ability is automatically improved.

Another advantage of concept maps

for the teacher is that it acts as an aid in instructional designs. It is an attempt to match the cognitive structure of Ss in accordance with their mental age. Thus, a concept Map favours psychological organisation of the subject being taught. Instruction through Concept Maps helps the teachers to programme the instructional process and also to assess student's understanding

The instrumental challenge seems to lie in helping students to construct networks of meanings that are consistent with conventional science, and this can easily be achieved by using concept maps

Concept Mapping in Chemistry

The vital importance of a well-organised knowledge network is evident from the recent literature on student "misconceptions". Within the "misconceptions" research framework, it has frequently been demonstrated that students have an everyday (non-scientific) understanding of some topics even before they are taught to them, and that, often teaching does not change these views. Furthermore, even when students have not been acquainted with a topic previously, teaching can lead to knowledge gaps, confusion and misunderstandings, each of which may be labelled as a misconception. In many scientific areas, these misconceptions have been identified before and after teaching. Researchers and teachers have often sought ways of making the best use of this information, both in planning their initial teaching strategies and in later remedial work. Clearly, it is better to anticipate difficulties and, if possible, avoid them or plan to eradicate it.

The teaching on the basis of Concept Mapping may lead to the development of the Concept. In Chemistry, teaching through Concept Mapping may lead to the formation of the Concept. The misconception, if identified after teaching, can be greatly reduced when the sources of these misconceptions were specifically addressed during teaching process.

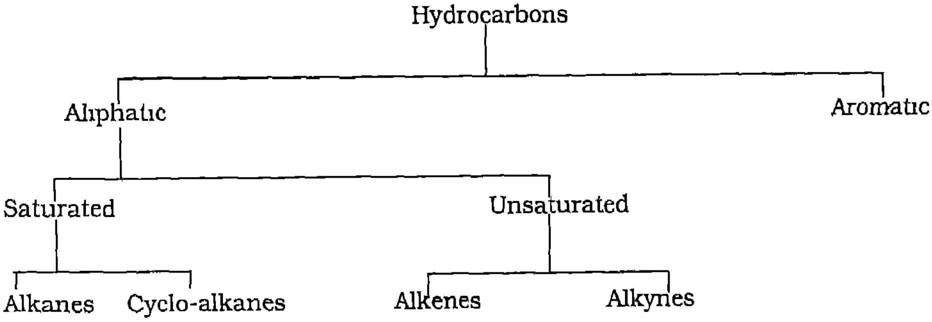


Fig. 1 Classification of Hydrocarbons

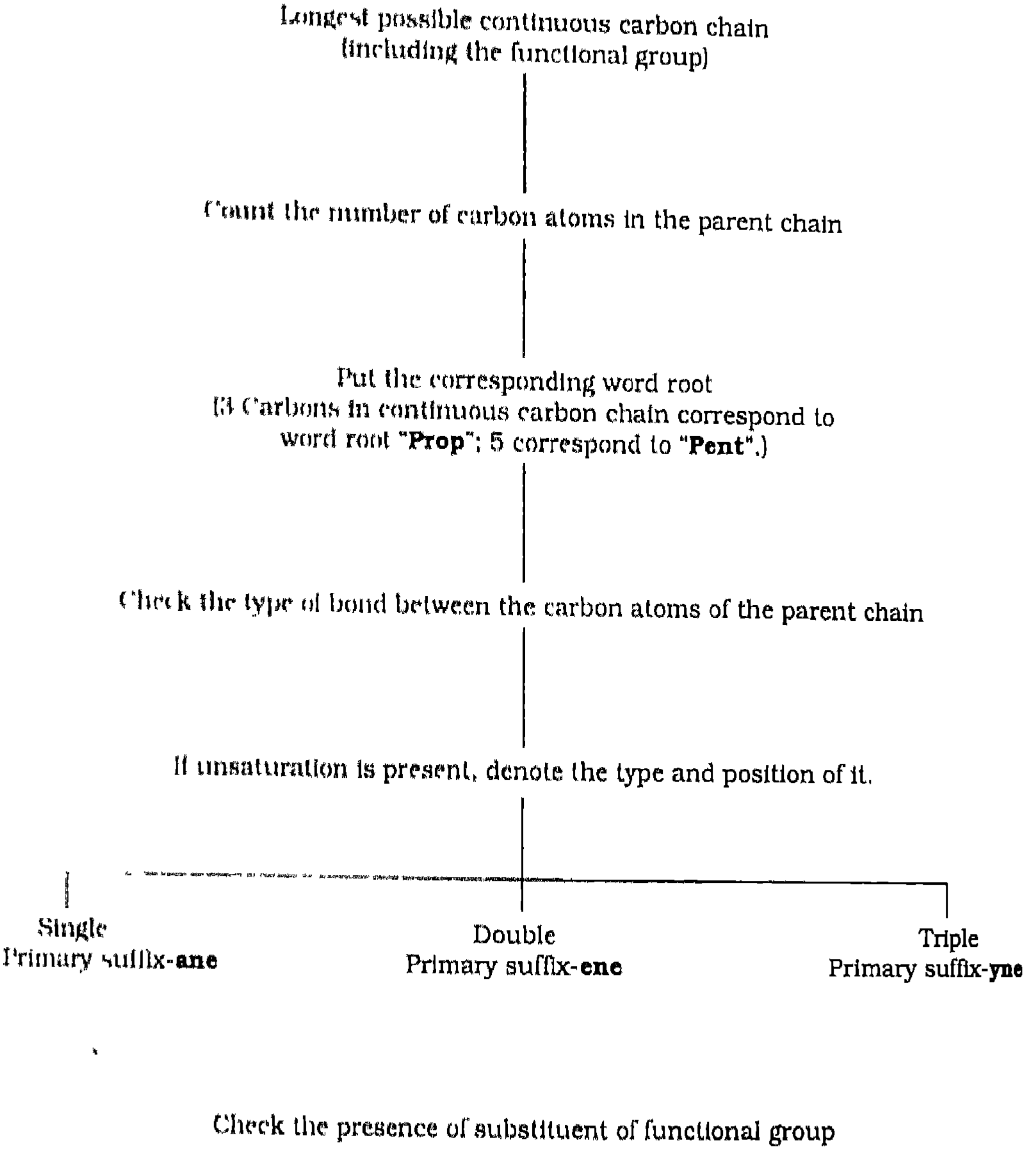
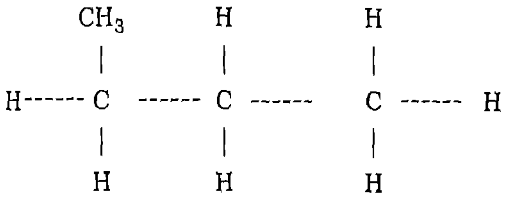

Longest possible continuous carbon chain (including the functional group)
Count the number of carbon atoms in the parent chain
Put the corresponding word root (3 Carbons in continuous carbon chain correspond to word root "**Prop**"; 5 correspond to "**Pent**".)
Check the type of bond between the carbon atoms of the parent chain
If unsaturation is present, denote the type and position of it.
Single Primary suffix-**ane**
Double Primary suffix-**ene**
Triple Primary suffix-**yne**
Check the presence of substituent of functional group

Fig. 2 Nomenclature of Hydrocarbons

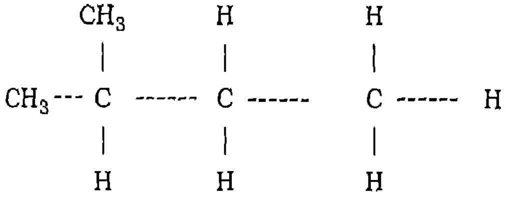
Put the name of substituent as a prefix

Example:
Methyle - Propane
Prefix - Longest Chain



$$\begin{array}{ccccccc} & \mathrm{CH_3} & & \mathrm{H} & & \mathrm{H} & \\ & | & & | & & | & \\ \mathrm{H}\text{------} & \mathrm{C} & \text{------} & \mathrm{C} & \text{------} & \mathrm{C} & \text{------}\,\mathrm{H} \\ & | & & | & & | & \\ & \mathrm{H} & & \mathrm{H} & & \mathrm{H} & \end{array}$$

Di Methyle - Propane



$$\begin{array}{ccccccc} & \mathrm{CH_3} & & \mathrm{H} & & \mathrm{H} & \\ & | & & | & & | & \\ \mathrm{CH_3}\text{---} & \mathrm{C} & \text{------} & \mathrm{C} & \text{------} & \mathrm{C} & \text{------}\,\mathrm{H} \\ & | & & | & & | & \\ & \mathrm{H} & & \mathrm{H} & & \mathrm{H} & \end{array}$$

Functional Group
— OH use suffix - **ol**
— CHO use suffix - **al**
— COOH use suffix - **oic acid**
— $CONH_2$ use suffix - **amide**
— CO\
    >O use suffix - **oic anhydride**
— CO/
O
|| use suffix - **one**
—C—
-O-use suffix - **alkoxyalkane**
O
||
-C-X use suffix - **oyl halide**
halo prefix --- X ---
alkyl prefix ---- COOR **oate**

Amino	--- NH_2
Imino	--- NH ---
Nitroso	--- N = O
Nitrile	--- CN
Isonitrile	--- NC
Cyanate	--- CNO
Isocyanate	--- NCO
Nitro	--- NO_2
Thiol	--- SH
Thioether	--- S ---

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Science News

India's First Meteorological Satellite in Space

INDIA successfully launched its first exclusive Meteorological Satellite (METSAT) into Geosynchronous Transfer Orbit (GTO) when its seventh flight conducted from Satish Dhawan Space Centre, (SHAR) Sriharikota, the Polar Satellite Launch Vehicle (PSLV-C4), carrying METSAT lifted off at 3.55 pm IST on September 12, 2002. This is the first time that PSLV was used to launch a satellite into GTO; in all its previous flights, PSLV was used to place Indian Remote Sensing (IRS) satellites and other auxiliary payloads in polar orbits.

About 20 minutes after the launch, the satellite was injected into GTO with a perigee (nearest point to Earth) of 218 km and an apogee (farthest point to Earth) of 34,700 km with an orbital inclination of 17.7 deg. with respect to the equator with an orbital period of about 10.5 hours. Immediately after its injection, the solar array on board the satellite were deployed automatically as per the plan.

PSLV-C4 lifted off from Sriharikota with the ignition of the core first stage and four strap-on motors. The remaining two strap-on motors of the first stage were ignited at 25 seconds after lift-off. The major phases of the flight included the ignition of the second, third and fourth stages and their smooth separation after burn-out, separation of payload fairing after the vehicle had cleared the dense atmosphere and the injection of the METSAT into the GTO. The total flight duration from PSLV-C4 lift-off to METSAT separation from the fourth stage of PSLV in GTO was 1211 seconds (about 20 minutes). The major changes made in PSLV since its previous launch in October 2001 included the improvements in the performance of the third stage solid propellant motor by optimising the motor case and propellant loading Also, the propellant in the fourth stage liquid propellant motor had been increased from 2 tonne to 2.5 tonne. Besides, PSLV-C4 employed a carbon fibre composite payload adopter. All these have resulted in substantial payload advantage.

It may be recalled that PSLV was initially designed for launching 900 kg Indian Remote Sensing Satellites into a 900 km polar sun synchronous orbit Since its first launch in 1993, it has been successively improved to enhance its capability. In its PSLV-C4 configuration, the 44.4-metre tall, 295 tonne PSLV has four stages using solid and liquid propulsion systems alternately. The first stage is one of the largest solid propellant boosters in the world and carries 138 tonnes of Hydroxyl Terminated Poly Butadiene (HTPB) based propellant. It has a diameter of 2.8 m. The motor case is made of maraging steel. The booster develops a maximum thrust of about 4,628 kilo newton (kN). Six strap-on motors, four of which are ignited on the ground, augment the first stage thrust Each of these solid propellant strap-on motors carries nine tonne of HTPB propellant and produces 662 kN thrust. The second stage employs the Vikas engine which carries 40 tonnes of liquid propellant — Unsymmetrical Di-Methyl Hydrazine (UDMH) as fuel and Nitrogen Tetroxide (N_2O_4) as oxidiser. It generates a maximum thrust of about 725 kN. The third stage uses 7.6 tonne of HTPB-based solid propellant and produces a maximum thrust of 260 kN. Its motor case is made of polyaramide fibre composite. The fourth and the terminal stage of PSLV has a twin engine configuration using liquid propellant. With a propellant loading of 2.5 tonne (Mono-methyl hydrazine and mixed oxides of Nitrogen), each of these engines generates a maximum thrust of 7.4 kN. The 3.2 m diameter metallic bulbous payload fairing of PSLV protects the spacecraft during the atmospheric regime of the flight.

METSAT

METSAT, launched by PSLV C4, is the first exclusive meteorological satellite built by Indian Space Research Organisation (ISRO). So far, meteorological services had been combined with telecommunication and television services in the Indian Telecommunications Satellite (INSAT) system. METSAT will be a precursor to the future INSAT system that will have separate satellites for meteorology and telecommunication and broadcasting services. This will enable larger capacity to be built into INSAT satellites, both in terms of transponders and their radiated power, without the design constraints imposed by meteorological instruments.

For meteorological observation, METSAT carries a Very High Resolution Radiometer (VHRR), capable of imaging the Earth in the visible, thermal infrared and water vapour bands. It also carries a Data Relay Transponder (DRT) for collecting data from unattended meteorological platforms. METSAT will relay the data sent by these platforms to the Meteorological Data Utilisation Centre at New Delhi. Such platforms have been installed all over the country.

At the time of its launch, METSAT weighed 1055 kg, including about 560 kg of propellant. The propellant, carried by METSAT, has been meant to be utilised to raise the satellite from GTO to its final Geostationary Orbit. METSAT is now located at 74 deg. East longitude.

METSAT has been designed using a new spacecraft bus, employing lightweight structural elements like Carbon Fibre Reinforced Plastic (CFRP). The satellite has a solar array generating 550 watts of power.

The successful deployment of the solar array immediately after its injection into GTO as well as the general health of the satellite were monitored by a ground station of the ISRO Telemetry, Tracking and Command (ISTRAC) network located on the Indonesian island of Biak. The Master Control Facility (MCF) at Hassan in Karnataka has taken control of METSAT for all its post-launch operations. Ground stations at Lake Cowichan (Canada), Fucino (Italy) and Beijing (China) supported MCF in monitoring the health of the satellite and its orbit raising operations.

The successful launch of MARSET was followed with the orbit raising manoeuvers that were conducted during the next week from MCF, Hassan and the spacecraft was finally positioned in its designated orbital slot of 74° East on September 24, 2002. In the second orbit-raising manoeuvre operations were conducted on September 14, 2002 from the Master Control Facility at Hassan. With this operation, the perigee (nearest point to Earth) of METSAT was further raised to 34,400 km while the apogee (farthest point to Earth) was at 34,500 km This further reduced the inclination of the orbit to 0 3° with respect to the equatorial plane while the orbital period of METSAT then became 22 hours 45 min Further orbital manoeuvres were carried out subsequently to move it to its designated slot at 74° East longitude.

The Very High Resolution Radiometer (VHRR) on board METSAT, was successfully switched on from Master Control Facility, Hassan at 12 45 hours on September 19, 2002 The earth image in the Visible Spectral Band was taken in full-frame mode, which covers the full earth disc and the adjoining deep space. The earth imaging in Water Vapour and Infra-red spectral bands were commanded on September 20, 2002. The images taken in the Visible, Water Vapour and Thermal Infra-red spectral bands received at the Master Control Facility are of excellent quality.

VHRR on board METSAT has the capability to take images of earth in three spectral bands — Visible, Water Vapour and Thermal Infra-red. The pictures provide a spatial resolution of 2 km × 2 km in Visible band and 8 km × 8 km in Water Vapour and Thermal Infra-red bands. In addition to VHRR, the METSAT carries a Data Relay Transponder (DRT) configured to collect local meteorological information from unattended data collection platforms and relay them to the Meteorological Data Utilisation Centre at New Delhi.

The successful launch of the satellite has been possible due to collaborative and dedicated efforts of a large number of scientists, engineers and other workers belonging to many organisations The Vikram Sarabhai Space Centre, Thiruvananthapuram designed and developed PSLV. The ISRO Inertial Systems Unit at Thiruvananthapuram developed the inertial systems for the vehicle The liquid Propulsion Systems Centre at Thiruvananthapuram developed the liquid propulsion stages for the second and fourth stages of PSLV as well as the reaction control systems. Satish Dhawan Space Centre, (SHAR) processed solid motors and carried out launch operations. ISTRAC provides Telemetry, Tracking and Command support ISRO Satellite Centre, Bangalore developed METSAT. Space Applications Centre, Ahmedabad developed the meteorological payloads. Master Control Facility at Hassan is responsible for all post launch operations on the satellite. Several industries and academic institutions were involved in today's PSLV-C4/METSAT mission.

The successful launch of METSAT into GTO has proved the versatility of PSLV to launch both Polar and Geostationary satellites. Together with GSLV, it will enable India to launch communication and meteorology and remote sensing satellites of different weight classes. The exclusive meteorological satellite, METSAT, once commissioned, is expected to vastly improve the meteorological services being provided by INSAT systems.

Source. Press Release; ISRO website

A Trillion Pieces of Pi

The number pi (π) represents the ratio of a circle's circumference to its diameter. Starting with 3.141 5926535897932384...., its digits run on forever. That hasn't stopped researchers from trying to calculate as many of those digits as computer technology and mathematical methods allow.

Computer scientist Yasumasa Kanada and his coworkers at the Information Technology Center, University of Tokyo, Japan have now succeeded in computing 1,241,100, 000,000 decimal digits of pi (π). With this they have succeeded in breaking their own previous world record of 206,158,430,000 digits, set in 1999. The calculation required about 602 hours on a Hitachi SR8000 computer, with access to a memory of about 1 terabyte.

To calculate the digits of pi, Kanada and his team used formulas involving arctangent relations of pi. For instance, you can use the following expression to work out the value of the arctangent of x to any desired number of decimal places just by evaluating the series to a sufficiently large number of terms:

Arctangent $(x) = x - x^3/3 + x^5/5 - x^7/7 + x^9/9 - \ldots$

The value of pi can then be obtained from the following equation:

$\pi = 16$ arctangent$(1/5) - 4$ arctangent $(1/239)$.

By using two different formulas, the researchers were able to compare the outputs and certify the calculation's accuracy.

Improvements in the computer algorithm used for the main calculation also contributed to the feat. Kanada estimates that if the new version of the algorithm had been applied in 1999 to compute 206 billion digits of pi, the total calculation time on the same computer would have been cut from 83 to 38 hours.

The 1,241,100,000,000th decimal digit of pi (not counting the initial digit, 3) is 5. Kanada began with analysing the statistical distribution of the digits of pi. The expectation is that each of the digits from 0 to 9 should appear about one-tenth of the time. In other words, you would expect the digit 7 to appear 80 billion times among the first 800 billion digits of pi. It actually occurs 79,999,775,965 times—close to the expected value.

Novel Gene Therapy Technique Devised

Researchers at Stanford University Medical Center, USA have devised a way to sneak DNA into skin cells taken from people with a potentially deadly genetic skin disorder. These modified cells later formed normal, healthy skin when transplanted on to the skin of mice. The technique marks the first time researchers have stably replaced the mutated gene in this disease and introduces a new gene therapy technique that could be useful in a wide range of diseases.

Paul Khavari, PhD, Associate Professor of Dermatology at Stanford and the team leader envisages that although the study was performed in mice but it would ultimately help in grafting of human disease tissues. The technique has shown the potential that it could one day help in the treatment of a variety of diseases. Not only can it accommodate large genes such as those responsible for Duchene's muscular dystrophy and cystic fibrosis, but also it can cause the gene to integrate into human chromosomes in locations where it will continue to make protein as long as the cell is alive. In other techniques, the inserted DNA does not become part of the chromosome and eventually breaks down or else integrates in positions where the gene gets turned off.

According to Michele Calos, PhD, Associate Professor of Genetics who developed the technique, although the present paper is the first published report of her approach being used to treat one disease, early trials in other disease models look promising. It has proved effective in this application and we hope it works just as well for other diseases

In their research paper, Khavari and Calos have reported on testing of the new technique in a disease called recessive dystrophic epidermolysis bullosa (RDEB) in which the outer layer of skin is not firmly attached to the underlying layers. When children with RDEB encounter friction or trauma, the outer layer of skin simply peels away — even from such friction as a parent picking up the child. The children have severe blistering, scarring, infections, and often don't live a normal life span.

Researchers know that RDEB is caused by a mutation in a single gene, whose protein type-VII collagen migrates to the lower side of the skin cell where it acts as a glue to anchor that cell in place. An ideal gene therapy for this disease would insert a copy of the gene into the skin cells where it could produce normal type-VII collagen. The problem is that the gene is too large to work in most standard gene therapy techniques. Khavari expects that Calos' technique would provide a way around the gene's large size According to him, this approach has the potential to make gene therapy work in this disease and in a lot of cases where gene therapy hasn't been working.

Calos' technique hijacks a mechanism used by a bacteria-infecting virus (called a bacteriophage) to integrate its genes into bacteria. The bacteriophage makes a protein called integrase that inserts a gene into a specific DNA sequence on the bacteria DNA. It turns out that humans also have a version of that DNA sequence. When the researchers insert a copy of the therapeutic gene and a gene coding for integrase into a human cell, the integrase inserts the gene into the human sequence.

To test Calos' technique in RDEB, Susana Ortiz-Urda, PhD, a post-doctoral fellow in Khavari's lab, took skin samples from four children with RDEB. The samples included skin stem cells that replenish the outer skin layer as it sloughs off. She then inserted the integrase DNA along with the gene that treats RDEB. In the lab dish, these cells all made normal levels of type-VII collagen.

Once the researchers established that the skin stem cells contained working type-VII collagen, they transplanted those cells on to mice where they formed normal skin tissue. The altered skin cells contained type-VII collagen in the proper location and looked like normal skin under the microscope. Although it has only been a few months since the mice received the transplants, Khavari is confident that the stem cells should exist throughout a person's life and should provide a continuous supply of normal skin cells.

The technique allows integration of therapeutic genes into stem cells, which support long-term gene-delivery. However, researchers warn that it could take many years for the technique to get established through a large number of tests before it could be used in people. The history of gene therapy shows that there are many steps that we have to take before bringing this to humans.

Source : Internet

Speed of Light may not be Constant

A team of Australian scientists has proposed that the speed of light may not be a constant—a revolutionary idea that could unseat one of the most cherished laws of modern physics — Einstein's theory of relativity.

According to Paul Davies of Sydney, theoretical physicists at the Macquarie University, Australia and the leader of the team, it is possible that the speed of light has slowed over billions of years.

If the findings of the researchers prove to be correct, physicists will have to rethink many of their basic ideas about the laws of the universe, which implies giving up the theory of relativity and one of the most the familiar equation, i.e. $E = mc^2$ of physics. However, Paul Davies cautions that it doesn't mean we just throw out the theory of relativity, because it's in the nature of scientific revolution that the old theories become incorporated in the new ones.

The proposal based on the study conducted by Davies, and astrophysicists Tamara Davis and Charles Lineweaver from the University of New South Wales, Australia was presented in a research paper published in August 2002. The suggestion that the speed of light can change is based on data collected by UNSW astronomer John Webb, who posed a conundrum when he found that light from a distant quasar, a star-like object, had absorbed the wrong type of photons from interstellar clouds on its 12 billion year journey to earth. According to Davies, fundamentally Webb's observations meant that the structure of atoms emitting quasar light was slightly but ever so significantly different from the structure of atoms in humans.

The discrepancy could only be explained if either the electron charge, or the speed of light, had changed. But, this is the dilemma with which the researchers are faced It is so because two of the cherished laws of the universe are the law that electron charge shall not change and that the speed of light shall not change. To establish which of the two constants might not be that constant after all, Davies' team resorted to the study of black holes, mysterious astronomical bodies that suck in stars and other galactic features. They also applied another dogma of physics, the second law of thermodynamics, which Davies summarises as "you can't get something for nothing".

After considering that a change in the electron charge over time would violate the sacrosanct second law of thermodynamics, they concluded that the only option was to challenge the constancy of the speed of light. More study of quasar light is needed in order to validate Webb's observations, and to back up the proposal that light speed may vary, a theory Davies stresses represents only the first chink in the armour of the theory of relativity. In the mean time, however, the implications are as unclear as the unexplored depths of the universe itself

Davies asserts that if what they have suggested would be the beginning of a paradigm shift in physics, it would be like what happened 100 years ago with the theory of relativity and quantum theory. It could be that the possible change in light speed will only matter in the study of the large-scale structure of the universe, its origins and evolution. For example, varying light speed could explain why two distant and causally unconnected parts of the universe can be so similar even if, according to conventional thought, there has not been enough time for light or other forces to pass between them. It may only matter when scientists are studying effects over billions of years or billions of light years Or there may be startling implications that could change not only the way cosmologists view the universe but also its potential for human exploitation. For example, the theory of relativity says nothing can go faster than light. The accepted speed of light is 300,000 km (186,300 miles) per second.

Maybe it's possible to get around that restriction, in which case it would enthrall Star Trek fans because at the moment even at the speed of light it would take 100,000 years to cross the galaxy It's a bit of a bore really and if the speed of light limit could go, then who knows?

Source . Internet

Gene that Regulates Development of Heart Cells Identified

Scientists at the University of Pennsylvania School of Medicine, USA have identified and described a small gene that regulates the delicate balance involved in the healthy growth and replication of heart muscle cells.

According to Jonathan A. Epstein, MD, of Penn's Departments of Medicine and Cell and Developmental Biology, the finding is likely to be important for our understanding of the causes of congenital heart disease. It is also relevant for the attempts being made to regrow damaged heart muscle.

The newly identified heart gene, Hop (an acronym for homeodomain only protein) is a small protein that lacks certain residues required for DNA binding, but is activated early in foetal development and continues modulating the expression of cardiac-specific genes throughout life. Hop appears to bind directly to another important regulator of development, serum response factor (SRF), and block SRF from binding to DNA. By inhibiting the expression of SRF, Hop protects cardiac muscle cells from overdevelopment and from developing fatal abnormalities. Although scientists have made a lot of efforts to determine how SRF is regulated in different tissues, it is only now that they have been able to see that Hop plays a vital part.

Source : Internet

Expanding Universe may Collapse in 10 Billion Years

Recent discovery that the universe is expanding at an ever increasing rate has led many astronomers to forecast a dark and lonely future for our galaxy. According to some predictions, the rapidly accelerating universe will cause all galaxies to run away from each other until they are no longer visible. In this widely accepted scenario, our own Milky Way will become an isolated island adrift in a sea of totally black space 150 billion years from now.

But two new studies by the cosmologists at Stanford University, USA suggest that it may be time to rethink this popular view of a "runaway universe". Their study suggests that instead of expanding exponentially, our cosmos may be in danger of collapsing in a "mere" 10 to 20 billion years.

According to Professor Andrei Linde, a professor of physics at Stanford at present, the standard view is that the universe is speeding up and so they were surprised when their study suggested that a collapse could happen within such a short amount of time Linde and his wife, Renata Kallosh — also a professor of physics at Stanford — have also conducted two-companion studies that raise the possibility of a cosmic "big crunch" Linde says that they tried their best to come up with a good theory that explains the acceleration of the universe, but findings suggest otherwise. However, she pointed that their result is just a model and it is just part of the answer.

If the Linde-Kallosh model is correct, then the universe, which appears to accelerating now, will begin to slow down and contract. Linde asserts that the universe may be doomed to collapse and disappear. Everything we see now, and at a much larger distance that we cannot see, will collapse into a point smaller than a proton. Locally, it will be the same as if you were inside a black hole. You will just discontinue your existence

Source · Internet

From Home Grown Technology (HGT) Programme

In conventional industrial drying

systems, the energy requirement is large for removing the final traces of moisture in the product. This is because while the outer surface of the material gets dried quite fast, the insides still retains some moisture for a long time Further heating to remove the residual moisture often ends up in charring the outside leading to adverse effects on quality of the product At the same time, the removal of trace moisture is necessary as it enhances quality and shelf-life of the products of many chemical, pharmaceutical, agro, rubber and several organic material products.

One solution to this problem is to utilise conventional drying systems to dry up to 70 per cent of the moisture and then employ microwave dryers to remove the result of the moisture — that which is essentially trapped inside the material This methodology is possible because the microwave can easily penetrate into the material to be dried. Thus, when the microwave module is designed as an add-on module to a conventional drying system, significant reduction in the overall drying time is achieved. It also vies better energy and cost efficiencies. Industries keen on exporting their produce will find that this method would give their products an edge where removal of moisture to high degree is important.

M/s Hi Tek Engineers who have been making a range of conventional industrial drying systems (like Fluid Bed Dryers and Flash Dryers) have decided to integrate microwave dryer with their conventional dryers. The company has developed industrial microwave dryers with the help of Society for Applied Microwave Electronics Engineering and Research (SAMEER), Mumbai At present the company offers two basic models. One is fixed energy microwave source, generating 1 5 KW microwave and another a 5 KW, 2.45 GHz variable output source (ranges between 1.5 to 5 KW) Higher capacity systems can be built by cascading several such modules. While the basic magnetron is imported, all the other components are fabricated by the company and integrated into a safe and sturdy system

The crucial part in any industrial microwave dryer is the "applier" (drying chamber plus product transport mechanism across it). The microwave forms standing waves inside the applicator chamber and the raw material gets exposed to the microwaves for the specified duration. The SAMEER has the expertise and facility to design safe chambers which will not permit any leakage of the microwave to the surroundings. In fact, in India, SAMEER is the only agency that is qualified to certify the safety of microwave devices They use various sophisticated software to calculate the design parameters for various kinds of raw materials and loads.

At the moments the company has already interested a few large segments where industrial microwave dryers can make a big difference One prominent sector is the tea plantations, where the drying and curing of leaves are to be done to exact specifications of moisture, to retain the special aroma and flavour. Many of the tea plantations still use vintage drying systems and are energy [illegible] the rent. Further, due to the variations in the quality of their tea (mainly due to less control in the drying process), the price realisations are also quite low. The company had carried its equipment to Assam and demonstrated its working to a few tea plantations at a very small scale. It has generated a lot of interest. However, the idea is new to the tea plantations, so a sufficiently large level demonstration (say 25 KW) is planned to show conclusively the improvement in the quantity as well as in the flavour and aroma. This could eventually help the Indian tea industry reestablish the pre eminent name for quality that they had till recently in the international market.

Another very interesting application, which is at initial trial stages is on the offshore oil rigs. Microwave units can help the oil industry achieve easier separation of oil from water and must that come up while drilling Initial results are encouraging, and if this succeeds, it will open up a large market within the country and in west Asia.

Microwave dryers can be used profitably by agro-food industries. The company has already conducted successful trails for more than two dozen industries. Interested parties may contact us to discuss customised installations, either as an add-on to their existing drying systems or as new turnkey installations.

(*Source* : TIFAC News, July-September 2002)

Compiled by
R. Joshi

Book Reviews

The Many Phases of Matter
G. Venkataraman
University Press (India) Ltd
3-5-820, Hyderguda
Hyderabad-500001
Pp 94, Rs 30 00

SOLID, liquid and gas are the three common states of matter which an ordinary reader or a school-going student is familiar with. The terms phase and phase transition may be used to represent the state of a matter and the change of state, respectively. However, besides the usual phases and phase transitions, numerous other phases of matter and numerous phase transitions can be observed in Nature Some of these even exhibit very curious and bizarre characteristics. The various interesting and fascinating aspects concerning phase and phase transition are discussed in the book under review.

In a very down-to-earth and simplistic manner the author starts with what actually is meant by phase and then goes on to describe the various phase transitions that are possible on account of complicated interaction between atoms of the matter

Curiously, the phase transition is possible even within the solid state itself. The structural transition, for instance, involves a change of crystal structure, e.g , change from graphite to diamond that takes place by heating the former to a very high temperature under high pressure. In some cases, a transition in the solid state may not involve change in the lattice structure at all, e.g., magnetic transitions representing transition between a magnetic and a non-magnetic state. Systems containing molecules with non-spherical shapes may exhibit liquid-crystal phases On the other hand, molecular solids containing diatomic molecules, viz , I_2, O_2, N_2 etc , all become metallic at very high pressures. These wide variety of phase transitions occurring in Nature are discussed in the book under review.

The various transitions, in general, involve a change from a disordered state to an ordered state, or vice versa But how is order born out of disorder? This along with the involved concepts of symmetry breaking etc. are discussed by the author in a very illuminating and easily understandable manner.

When liquid helium is cooled to a temperature below 2.2°K interesting things happen. In this low temperature phase, the liquid helium flows without experiencing any viscosity at all and becomes a superfluid. Such a phenomenon, as exhibited by liquid helium, is called superfluidity. A superfluid transition is a complex phenomenon that involves quantum effects The explanation of superfluidity is, therefore, by no means, easy. However, the author has tried to explain the phenomena in a very interest-arousing and easy-to-follow manner.

The frictionless flow of electrons in a superconductor has strong similarities to the superfluidity of liquid helium. The superconducting phase and the recent advances in the field of superconductivity are discussed too.

The author finally tries to correlate the phase transition with the origin of life and the evolution of the early universe. Like systems in thermodynamic equilibrium there may also exist systems which are driven far from equilibrium. Such systems may seek new stable states and the jump to such new states can be visualised as a non-equilibrium phase transition.

The origin of life could be viewed as a non equilibrium phase transition. A physicist's concepts about life and death may also be linked to the equilibrium and non-equilibrium states. A living object may be taken to represent a state that is far from equilibrium. So, one can say that a non-equilibrium state represents life. However, if a living object is able to attain thermodynamic equilibrium, then it is dead! This may be said to be the new physicist's definition about death which the inquisitive readers can trace from the book.

Writing a popular book undoubtedly is a very challenging task. However, the author has proved himself to this challenge. There is no gain saying that the book is highly instructive and is a brilliant exposition of such an exotic topic as phase. One only wishes that the author had also devoted a couple of pages to plasmas — the fourth state of matter.

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Glimpses of the Future Science and Technology

Books Reviewed: *The Space Drama* and *The Interstellar Traveller*
Author: Dilip M. Salwi,
Publisher: A 'N' B Publishers Pvt. Ltd.,
O-11, Lajpat Nagar-II
New Delhi-110024
Pp. 64 and 65, Price Rs 75.00 each

SPACE and alien encounters have always been very popular themes with the Science Fiction (SF) writers. The idea of aliens points to the possibility of the existence of different words other than our own planet Earth. Science Fiction also points the route to the futuristic possibilities in the field of science and technology. Many futuristic stories have, therefore, been penned by a number of SF writers. The two collections of SF stories under review by the brilliant teller of SF bring before the readers the shape of things to come in the field of science and technology in the late 21st century.

The first collection *The Space Drama* starts with the story which deals with the bizarre concept of journey through a space-time tunnel to a different world Scientifically termed as a *wormhole* it acts as a tunnel between two very distant points in the universe. The character of the story experiences an exotic travel through the wormhole that is apparently created by some higher intelligence

Dinosaurs kept at a 21st century-Hunting Park give Tujo and Neema, the teenaged visitors to the Park, an experience of their lifetime. What do they encounter in the Park? One has to read on the story with holded breath to elicit the answer.

The misuse of technology has led to the perpetuation of hatred, selfishness, inhumanity and pollution on Earth. This is the outright conclusion reached by some aliens from the extraterrestrial world. They, therefore, feel terribly concerned about this and wish to salvage the society on the Earth. What is their modus operandi to achieve their end so that the earthlings learn to live in harmony with proper use of technology? The readers who are curious to know about this will have to leaf through the story 'The Allien Concern', a story with a deep-ingrained message indeed!

In the last story of the first collection, the world is saved from the danger of an impending nuclear holocaust, thanks to the brilliant idea of Dr Romel. The story drives home the fact that we have only one Earth that needs to be saved at any cost for the well-being of we humans and the entire civilisation on the Earth

The second collection *The Interstellar Traveller* starts with the adventure of Amit who comes across a strange spaceship A strange combination of a ship and a robot, the spaceship possesses the brains of its inventor too and has come from a distant star. Aptly called an interstellar traveller it loves to travel to different worlds orbiting different stars in the universe It convinces Amit about the existence of different worlds by offering him an exotic trip to these worlds A nicely woven story pointing to the possibility of the existence of extraterrestrial life

Even in the late 21st century, man's lust for gold remains unsatiated. This is what the SF *The Untold Tragedy at Asteroid XIV-586* would have us to believe. The story is about a space adventure to an asteroid containing gold. This 'gold rush' puts an ace pilot Capt. Mac Greal into real trouble Another Pilot Capt. Khan is, therefore, sent on a mission to find out what actually went wrong with Capt Mac Greal's mission. The findings of Capt. Khan flabbergasts the committee of the Asteroid Exploration Project. What were these findings? The readers will have to read the story with spell-bound attention to be seized of the mystery of the Asteroid XIV-586.

Scientists have been able to create Artificial Intelligence (AI) by copying the way the human mind or brain works. However, they have so far not been able to copy emotions which are illogical and apparently do not have any cause and effect. Also, the eyes through which humans, and even animals, express their deepest emotions, which sometimes even words fail to express, are highly complex organs and, therefore, very difficult to reproduce In the story 'Hey! Look at its Eyes', Ajinkyas, on seeing lack of emotions in the eyes of his electronic pet Toto feels disturbed at first, but later on reconciles when he is told that some pets based on AI are able to simulate emotions by their words and gestures only. The story drives home the hard fact that although human beings have tried to conquer nature and mimick its creations, the nature nevertheless has the last laugh. This is also highlighted in the last story where all the marvels created by humans get destroyed under the devastating effect of just one gravitational shock wave.

Written in a simple language and lucid style, the stories are basically meant for teenagers. However, they will also have appeal for the readers of all age groups giving them the glimpse of the future science and technology.

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Department of Science and Technology
Government of India

Kishore Vaigyanik Protsahan Yojana

An ongoing National programme of fellowships in Basic Sciences, Engineering and Medicine, to attract exceptionally bright and highly motivated students to research careers in these areas.

The Kishore Vaigyanik Protsahan Yojana is a programme initiated by the Government of India to encourage students of Basic Sciences, Engineering and Medicine to take up research careers in these areas.

The aim of the programme is to identify and encourage talented students with aptitude for research. This programme strives to assist the students to realise their potential and to ensure that the best scientific talent is tapped for research and development in the country. Generous scholarships will be provided (upto the pre-Ph D level) to the selected students In addition, summer programmes in prestigious research and educational, institutions the country will be organized, and preferential access to libraries, laboratories, museums etc , will be provided

Funded by the Department of Science and Technology, Government of India, the programme administered by the Indian Institute of Science (IIS) Bangalore, through the Society for Innovation and Development (IISc Campus). Selections for Basic Sciences, Engineering and Medicine Streams will be carried by IISc, IIT Bombay and ICMR (New Delhi), respectively.

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